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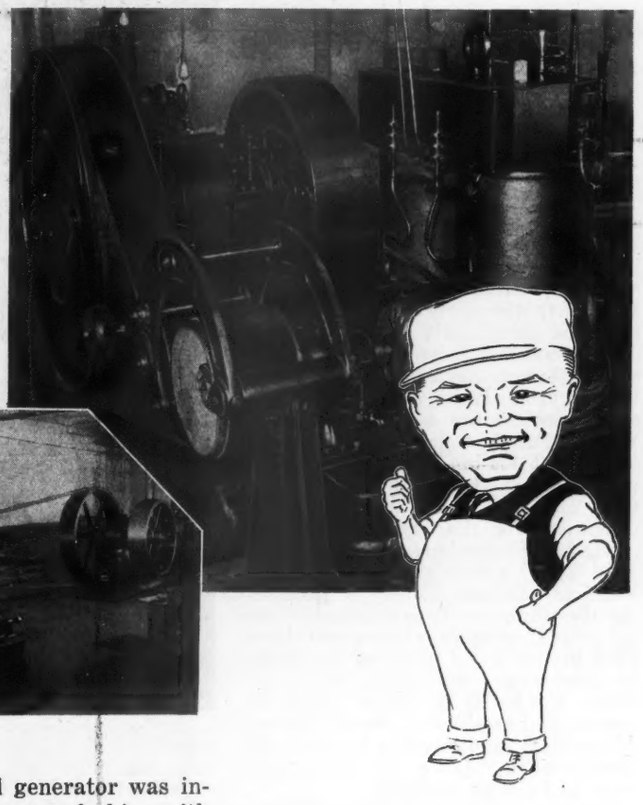
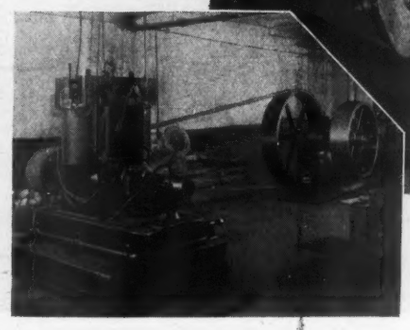
The Proof of a Good Installation Job

Usually Shows Up in Freedom From Operating Troubles When Reliable Equipment Is Used





I WANT to take this opportunity of thanking those of our readers who have offered suggestions and contributed subjects for comment on this page. Practically every one is good and while there are not enough issues during the year to make use of all your suggestions, you have probably noticed that they have been developed into leading articles or shorter articles that have appeared in the practical departments following the two pages of editorials in the second half of the paper.

Mr. Martin A. Diller, of Intercourse, Pa., in the following comment touches on a subject that has brought out some interesting information from a number of readers: "Let's try and stimulate more pictures for *Practical Pete* on record installations showing long life or low maintenance of equipment, motors, etc." Here are two pictures from Mr. Benjamin F. Clark, an engineer associated with F. L. Smidth and Company, New York City, that show how troubles charged to an old belt drive were cured by inexpensive changes and the troubles traced to an inefficient installation of the belt rather than its use.

Until the pulley centers were shortened and the drive changed as shown in the large photograph, on June 14, 1908, this drive was cussed and discussed on frequent occasions. The original belt connection for this 65-hp. engine and generator was installed in the customary fashion with the distance between pulley centers 16 ft. according to the style of good belt drives then in vogue. The operator continually reported flickering of lights in spite of high belt tension and large amounts of belt dressing, with the pulley faces lagged with canvas to prevent belt slippage with wide variations in load.

Finally the generator was moved closer to the engine and a Lenix type of drive installed with pulley centers of 6 ft. 6 in. Mr. Clark states that since the change was made on June 14, 1908, the installation has been in daily operation and is still going. With the exception of one new belt, not one cent has been spent on this installation except for lubrication and no flickering of lights has been experienced.

This is another example of how good equipment gets a black eye through no fault of its own, but through indifferent attention to the conditions under which it is forced to operate. There are ways and ways of doing things, with some much better than others, but the proof of the best way is freedom from operating troubles.

You probably have in your plant some idea that you have worked out that proves this point. If so send me a photo of the installation and details of the operation and the rest I will take care of on this page.

Practical Pete

Achievements of Benjamin G. Lamme

Who Died at His Home in East Liberty, Penna., July 8, 1924

AMONG engineers the world around the name of B. G. Lamme is associated with developments in electrical engineering from their beginnings. He joined the engineering staff of the Westinghouse Electric & Manufacturing Company in 1889 and since 1903 held the position of chief engineer. Mr. Lamme in the early days devoted his attention particularly to the perfection of railway and industrial motors and synchronous converters. His first spectacular achievement was the designing of the generating equipment for the World's Fair in Chicago in 1892. Then came the 5,000-hp. generators for Niagara Falls, the largest built up to that time and the generating and motor equipment for the first large railway electrification project, installed by the New York, New Haven and Hartford Railroad. During the '90's he produced the Westinghouse Type C induction motor with squirrel-cage rotor and developed his advanced ideas on the design of synchronous converters, which furnished the battle ground of much discussion and established the background of practical fundamentals on which Mr. Lamme always based his development work and design theories.

Up to the time of his death he was always working on the perfection of existing or newly-developed equipment. His last large job was the design of the 62,500-kva. generator installed by the Brooklyn Edison Company last year. During the past thirty-five years more than 150 patents have been issued to him individually.

Mr. Lamme was well known for his ability to conceive the practical details of design from a mathematical study of the desired characteristics of a machine. At the very start of his career he showed a dislike for the cut-and-try methods of design then in vogue and began to develop methods for calculating designs on paper and building them from his conclusions. Scarcely six months after entering the employ of the Westinghouse Company, he calculated the electrical design of the double-reduction gear railway motor which was put on the market early in 1890. This was very similar in design to others that were in use at that time, so that this first piece of work showed litt'e more than an ability to make the calculations of the magnetic circuit and determine the saturation curve.

In the summer of 1890, however, Mr. Lamme began work on the design of a street car motor with a single gear reduction. This was the forerunner of the celebrated Westinghouse No. 3 motor which set a standard for street car motors that still persists. It was radically different from anything that had appeared previously, with slotted armature, wound coils and a wave winding. Its success, when put out early in 1891, was instantaneous.

At this time, he was working on direct-current arc machines and alternating-current generators, making improvements in the latter which increased their output by 50 per cent. In 1892, he began work on the induction motor and produced the first successful, distributed-winding motor of this type. In 1892, Mr. Westinghouse took the contract for lighting the World's Fair. Great polyphase generators had to be designed for this purpose and Mr. Lamme did the work. He also designed the synchronous converter, large induction motor and other machines which were exhibited at the Fair. At this time he was designing railway generators whose performance was the boast of the Westinghouse Company.

Then came the Niagara Falls power development, for which Mr. Westinghouse took the contract for the electrical apparatus. The huge umbrella-type generators rated at 5,000 hp. each, were calculated to a nicety by Mr. Lamme, and the machines were a great success. About the year 1895, Mr. Lamme conceived the idea that led to the development of the type C, induction motor with squirrel-cage rotor.

However, he regarded his work on the synchronous converter as one of his greatest achievements. For years he fought, almost single-handed, the battle for the synchronous converter—and won out. This is now the accepted machinery for converting alternating into direct current.

Then came his conception of the single-phase, alternating-current railway system. After several attempts, Mr. Lamme succeeded in designing a series, commutator-type of motor with suitable characteristics, which he described along with the system of power distribution in his famous paper before the American Institute of Electrical Engineers.

The paper created a furore of excitement all over the world and soon every electrical manufacturer was working madly on the problems, and a dozen types of motors were on the market. Mr. Lamme never pinned his faith solely to the commutator-type motor, although that is the type that has been most used. He maintained that one of the great advantages of the system lay in the fact that several different types of equipment could be used, all running under the same trolley.

Mr. Lamme was not a prolific writer, but when he did write, the engineering world read with profound respect. He had the happy faculty of being able to put his thoughts on paper so that anyone with the rudiments of the subject could understand them. He seldom wrote mathematical papers, although not for lack of ability; he regarded mathematics as his tools that were to be put away when the work was done. Consequently, his papers are in great demand and are very widely read.

The American Institute of Electrical Engineers bestowed a high honor on Mr. Lamme by electing him one of the two members from that body on the Naval Consulting Board during the War. He was also chairman of the inventions committee on that Board. In 1919 he was also awarded the Edison Medal by the American Institute of Electrical Engineers for his engineering achievements. All of these were in consequence of his work and ability as an engineer. When the Board of Trustees of Ohio State University awarded him the Joseph Sullivant Medal. it was a recognition of the value of his engineering work to the world.

Mr. Lamme's greatness as an outstanding electrical engineer can best be judged by the eagerness with which engineers always sought his opinion and discussion.

B. G. Lamme was born on a farm near Springfield, Ohio, January 12, 1864. He entered Ohio State University in 1883 and was graduated in mechanical engineering in 1888.

The following is a list of 161 patents issued to B. G. Lamme, covering the patent number, subject and date filed. As far as the records show, this list is complete up to the present.

No. 488,016—Armature for electric machines. Feb. 8, 1892.
No. 513,401—Electric motor for street cars, March 27, 1893.
No. 513,693—Controlling switch for electric railways, Feb. 25, 1893.
No. 519,098—Self-exciting, constant-potential electric generator, Feb. 20, 1890.
No. 519,862—Method of, and means for, starting synchronous motors, April 5, 1893.
No. 520,965—System of electrical distribution, March 27, 1893.
No. 527,066—Device for protecting separately-excited generators, Feb. 28, 1894.
No. 550,354—Self-exciting, constant-current alternator, Aug. 24, 1891.
No. 556,891—Support for field-magnet coils, Sept. 4, 1895.
No. 559,721—System of electrical distribution, April 11, 1895.
No. 561,593—Dynamo-electric generator, Sept. 4, 1895.
No. 564,702—Alternating-current generator, April 30, 1894.
No. 564,703—Alternating-current generator, June 30, 1894.
No. 565,284—Compound-wound, polyphase generator, June 4, 1895.
No. 571,836—System of a.c. regulation and distribution, April 6, 1896.

Six well-known machines designed by Mr. Lamme.

A. Single-reduction, four-pole, wave-wound railway motor. *B.* Single-phase, 25-cycle, commutator-type motor for New York, New Haven and Hartford Railroad. *C.* Umbrella-type, 5,000-hp. generators installed at Niagara Falls nearly thirty years ago. *D.* Single-phase, 60-cycle induction motor developed in 1895. *E* and *F.* Two of Mr. Lamme's early designs of rotary converters.

No. 573,009—Direct-current, dynamo-electric generator, March 11, 1895.
No. 12,406—Direct-current, dynamo-electric generator. Original No. 573,009, dated Dec. 15, 1896. Application for reissue filed May 2, 1905.
No. 574,035—Method of, and means for, regulating a.c. generators, March 11, 1896.
No. 574,914—Means for adjusting compound-wound dynamos, Dec. 28, 1893.
No. 582,131—Alternating-current regulation and distribution, March 27, 1893.
No. 582,132—Alternating-current motor, Oct. 30, 1895.
No. 588,279—Direct-current generator, May 8, 1896.
No. 589,838—Coil for electric machines and method of making same, April 17, 1897.
No. 589,839—Armature for electrical generators and motors, July 2, 1897.
No. 599,940—Non-synchronous electric motor, April 30, 1894.
No. 599,941—Direct-current electrical machine. Original application filed May 8, 1896. Divided and this application filed July 8, 1897.
No. 599,942—Inductor dynamo, July 12, 1897.
No. 599,943—System of electrical distribution, Sept. 18, 1897.
No. 606,015—System of electrical distribution and regulation, Feb. 10, 1898.
No. 606,560—Regulation of rotary-transformer direct-current electromotive force, Feb. 10, 1898.
No. 606,589—System of electrical distribution, Jan. 28, 1897.
No. 607,621—System of electrical distribution. Original application filed Jan. 28, 1897. Divided and this application filed Dec. 16, 1897.
No. 609,990—Means for controlling non-synchronous a.c. motors, March 11, 1896.
No. 609,991—Method of, and means for, securing constant torque in polyphase motors, Feb. 10, 1898.
No. 610,067—Induction motor, July 22, 1897.
No. 620,333—Direct-current motor and method of operating same, Dec. 16, 1897.
No. 620,334—Direct-current system of electrical distribution, Aug. 4, 1898.
No. 620,335—Method of, and means for, varying speed of d.c. motors, Sept. 3, 1898.
No. 620,336—System of electrical distribution and regulation, Sept. 28, 1898.
No. 626,172—Rotary transformer or synchronous motor, July 24, 1897.
No. 633,855—System of electrical distribution, Jan. 30, 1899.

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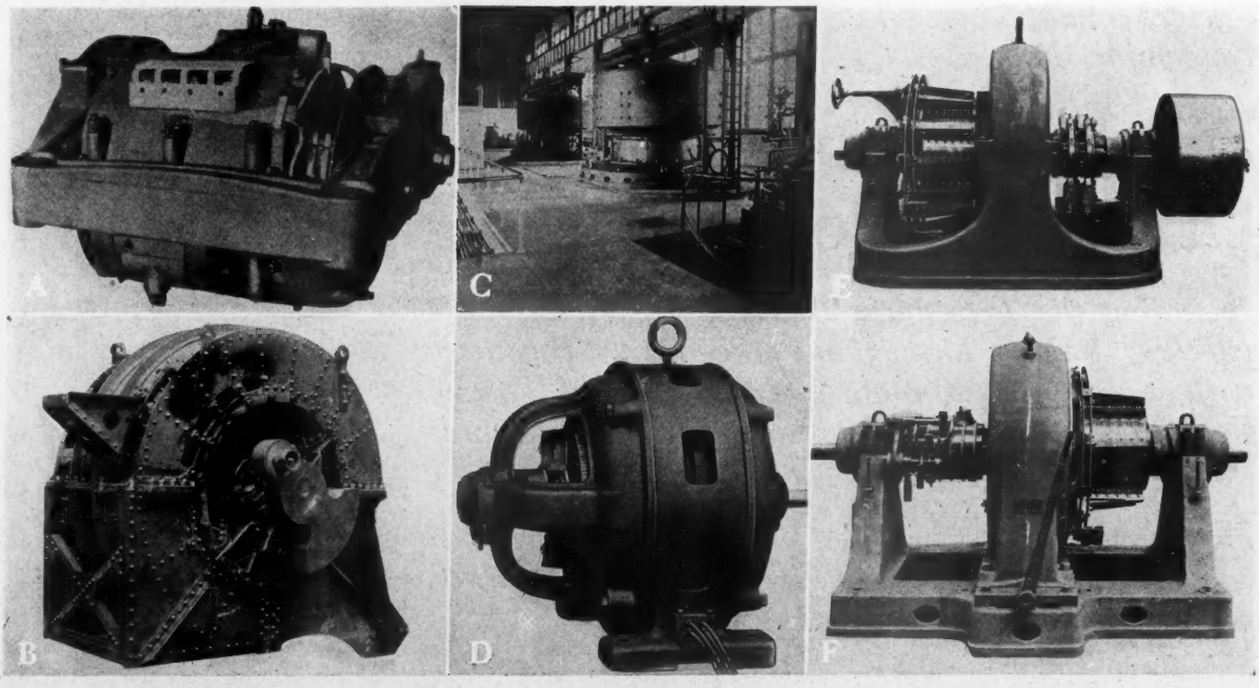
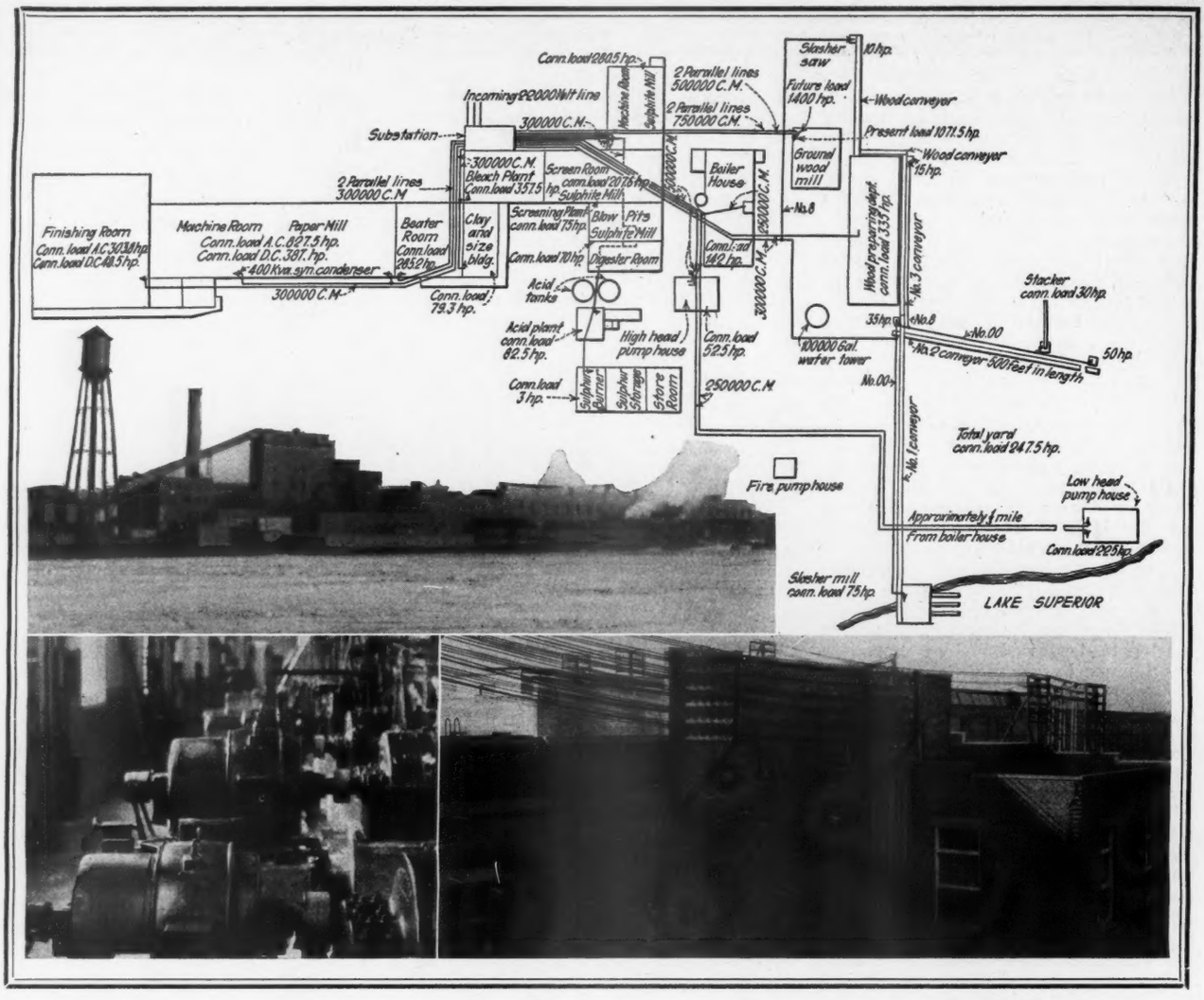




Factors That Determine the

Details of Paper-Mill Drives and Power Service

Including the Transformation and Distribution of Electric Power Throughout the Mill, Together with the Types of Motors and Kinds of Drive Used to Connect the Motors to Their Loads and the Characteristics of Paper-Mill Loads

By H. E. STAFFORD

Electrical Engineer, Provincial Paper Mills, Ltd., Port Arthur, Ontario

Fig. 1—Power distribution system of the Paper Mill shown in the center illustration.

Power is received at the substation shown at the top center of the drawing at 22,000 volts and is transformed to 575 volts and distributed to the various parts of the mill as is shown. The illustration at the lower right-hand corner shows the type of overhead distribution system used. This illustration shows the lines leaving the substation. The lower left-hand illustration shows part of the Harland drive in the *Book Mill.*

THE PLANT with which I am associated has a connected motor load of over 5,000 hp. It consists of a 50-ton sulphite-pulp mill, a 20-ton ground-wood mill and a 40-ton book mill. The sulphite-pulp mill employs a chemical process for converting wood into wood pulp for use in making paper. In the ground-wood mill, the wood is converted to wood pulp by actual grinding of the wood. In the book mill, the wood pulp is converted into book paper.

Outside of the steam plant, which supplies steam for cooking and bleaching the sulphite pulp and supplies steam to a turbo-generator which furnishes the power for the paper-machine drive, the mill is electrically operated throughout.

Power is purchased at 22,000 volts and stepped down to 575 volts at the company's sub-station. This is done by means of two banks of transformers, connected in parallel. One bank consists of three units of 1,250 kva. each, or a total of 3,750 kva. with 6 per cent reactance. This bank

is shown in Fig. 5. The other bank consists of three units of 350 kva. each, or a total of 1,050 kva., having 2.5 per cent reactance. The additional reactance required for parallel operation is supplied by three reactances connected in the low voltage delta of the 1,050-kva. bank, as is shown in Fig. 2.

The scheme of connection is delta-delta and each bank is connected to a separate bus, with a bus-tie connection between them. There are two switchboards and the bus-tie is so arranged that either board can be fed from either bank. This is an additional precaution for securing continuous operation. Fig. 2 shows a diagram of the connections between the two banks.

The incoming 22,000-volt line passes through an oil circuit breaker, protected by three inverse-time-limit relays which are connected through three bushing-type current transformers, the trip being operated from a 12-volt, direct-current bus. Each bank of transformers is operated by an oil circuit breaker with a.c. trip. The incoming line is protected by aluminum-cell lightning arresters, as is shown in Fig. 2.

OF ALL the industries in the United States, the paper industry ranks sixth in horsepower of installed motors and in total consumption of electrical energy. With more than a million horsepower in motors, the paper industry is consuming more than 2½ billion kw-hr. per year. Where an industry uses such large amounts of power, the problems that must be considered are: The transformation and distribution of this power to the various motor drives, the types and sizes of motors to be used, and the manner in which the motors are to be connected to their loads. In this article Mr. Stafford considers each of these points in detail. He also gives some very interesting information as to the characteristics of paper-mill loads.

The outgoing feeders from the sub-station were standardized by using 500,000-circ. mil, rubber-covered, stranded cable in 3-in. conduit, for all power runs. Where greater carrying capacity was necessary, two or more circuits of 500,000-circ. mil cable were paralleled. After leaving the substation the power cables were run on steel brackets, as shown in Fig. 4. All connections between rubber-covered and weatherproof cables were made with Dossert connectors. At the point of entrance to the various buildings, gutter boxes, equipped with bus supports, were installed and each motor was fed from a gutter box through an individual sealed service switch. Fig. 7 shows one of these layouts.

Table I shows the departments and subdivisions into which the mill is divided and also shows the connected load, average load and power factor of each subdivision. These data are charted in Fig. 3. Power is charged to each department on the basis of the average consumed.

Part of the wood for this paper mill comes by water and part by rail. Practically all the wood is in 8-ft. lengths, which have to be sawed into 4-ft. lengths for the sulphite mill, or into 2-ft. lengths for the groundwood mill. The conveyors are arranged so that the wood coming by water may be either run directly to the mill or to the storage yard. The conveyor that takes the wood to the storage pile in the summer also brings it to the mill in the winter.

The handling of the wood is seasonal; that is, part of the equipment is idle in the winter and part of it is idle in the summer. For instance, the slasher mill, No. 1 conveyor, stacker and stacker conveyor are idle from November 1st to May 1st, while the slasher saw and at least one of the portable conveyors are idle during the summer.

The average summer load of this department is 110 hp. while the average winter load is 42 hp. The average power factor is 50 per cent lagging. Table II contains a list of the motors in this department.

Motors and Drives Used in a Sulphite-Pulp Mill

The sulphite process consists of wood preparation, acid making, cooking, washing and screening the pulp, turning out the excess pulp in laps for shipment to other mills, and reclaiming the waste screenings into laps for building and wrapping paper. For convenience, this process is split into four departments: wood preparation, acid making, sulphite process and screenings plant.

In the wood preparation department, the wood is barked in huge drums and made into chips of a uniform size for cooking. The chips are

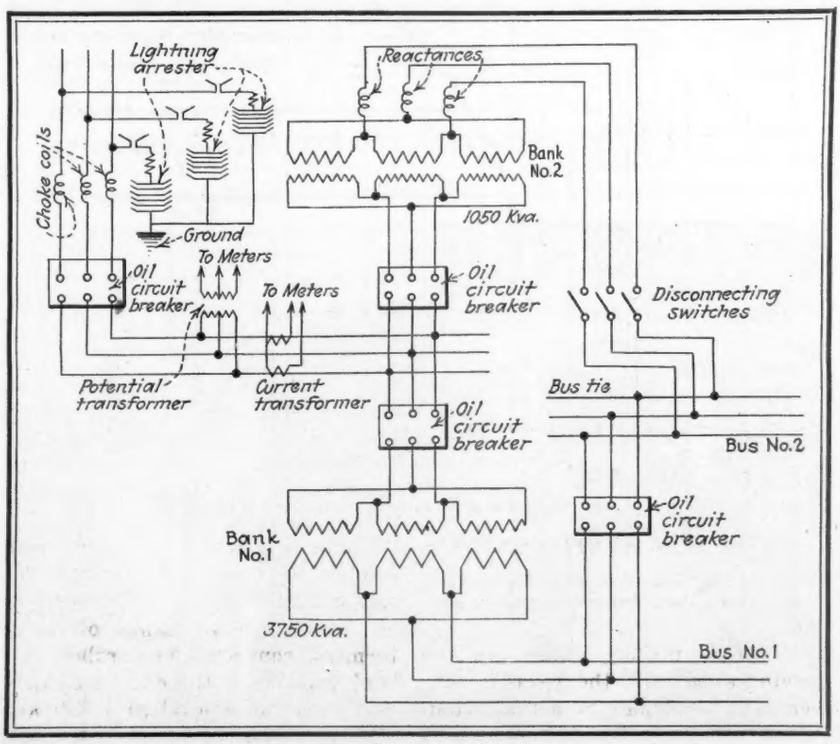


Fig. 2—This is the connection scheme of the transformers, switches and buses in the mill sub-station.

Note the external reactance connected in the low-tension side of the 1,050-kva. bank of transformers so that it can be operated in parallel with the other bank. By the arrangement of oil switches shown, No. 1 bank of transformers can feed either No. 1 or No. 2 bus. No. 2 bank of transformers is arranged to feed No. 2 bus only or to be operated in parallel with No. 1 bank to feed both buses. The feeders can be supplied from either bus.

screened to eliminate the sawdust and conveyed to a chip bin over the digesters. The average power used in this department is 164 hp., with a power factor of 68 per cent lagging. Table III shows the motor list.

In the acid making department, raw sulphur is burned and the gas thus formed is combined with other elements to form H_2SO_3, or sulphurous acid. This acid is afterward pumped to large storage tanks to be used in cooking the pulp. The average load of this department equals 50 hp. at 85 per cent lagging power factor. Table IV gives the motor list.

The sulphite-pulp process department includes the cooking, washing, screening and manufacture of pulp laps. There are two digesters, in which the cooking is done, each with a capacity of 16 tons of chips. The average load on the motors is 460 hp. with an average power factor of 85 per cent lagging. Table V shows the list of motors.

In the screenings plant, the screenings, slivers, knots and other refuse taken from the cellulose are refined by means of pebbles revolving within a drum, and the product thus formed is made into laps for shipment to mills making wrapping and building papers. The average load of this department is 65 hp. at 85 per cent lagging power factor. The motor list is shown in table VI.

Drive Applications Used in a Ground-Wood Mill

The ground-wood or mechanical-pulp mill may be divided into two departments: namely, wood preparation and ground-wood pulp process. The motors required for the preparation of the wood are given in Table VII, while Table VIII gives those for the pulp process.

Table I—Summary of Load in a Paper Mill

Department	Connected Load Hp.	Average Load Hp.	Power Factor Per-cent Lag	Table in Which Motors are Listed
I. Wood Handling	247.5	71	50	II
II. Sulphite Mill				
A. Wood Preparation	335.0	164	68	III
B. Acid Making	85.5	50	85	IV
C. Sulphite Process	684.4	460	85	V
D. Screenings Plant	75.0	65	85	VI
III. Ground-Wood Mill				
A. Wood Preparation	85.0	....	..	VII
B. Ground-wood Process	986.5	1290	98	VIII
IV. Bleach Plant	357.5	195	80	IX
V. Book Mill				
A. Clay and Size	79.3	30	50	X
B. Beater Room	285.2	275	85	XI
C. Machine Room				
1. A. C. Motors	827.5	660	100	XII
2. Harland Drive	359.0	.....	D. C.	XIII
3. Dry End	28.0	....	D. C.	XIV
4. Finishing End				
a. A. C	303.8	175	77	XV
b. D. C	48.5	....	D. C.	XVI
VI. Steam Plant	142.0	75	65	XVII
VII. Water Supply	750.0	415	65	XVIII
VIII. Miscellaneous	90.0	70	100	XIX

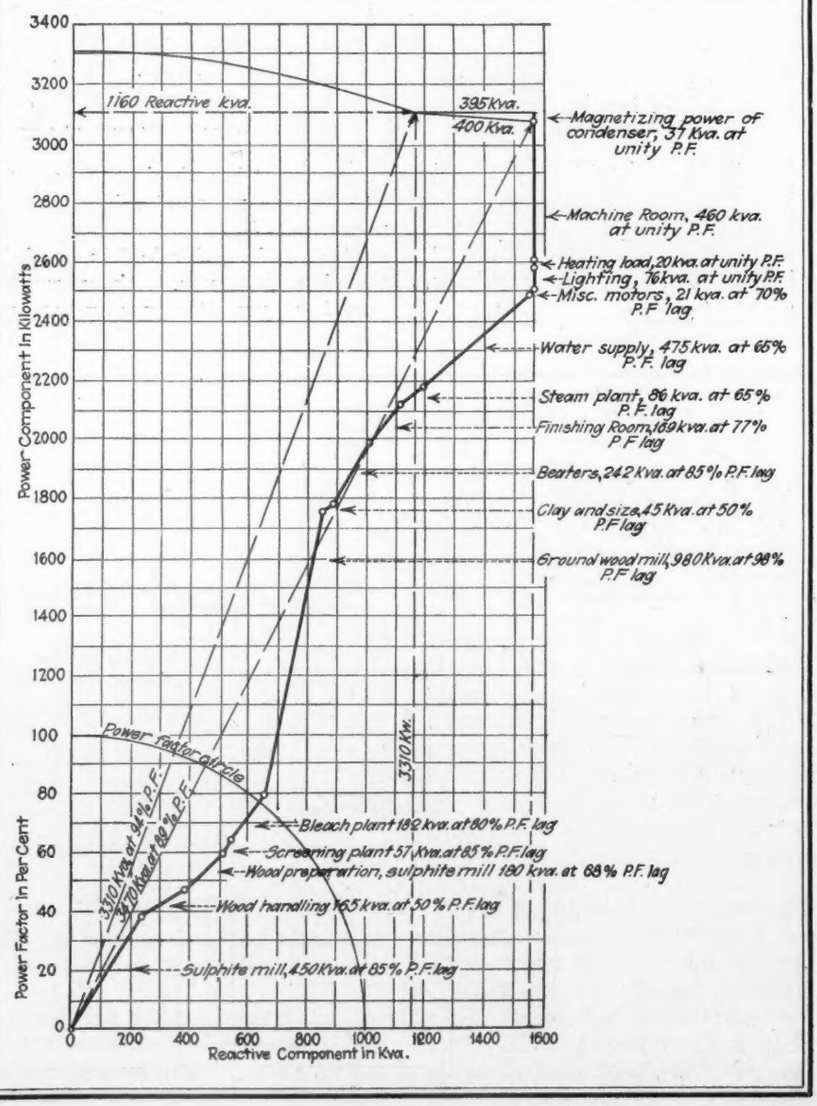

Power Component in Kilowatts
Power Factor in Per Cent
Reactive Component in Kva.
1160 Reactive kva.
395 kva.
400 kva.
Magnetizing power of condenser, 37 kva. at unity P.F.
Machine Room, 460 kva. at unity P.F.
Heating load, 20 kva. at unity P.F.
Lighting, 76 kva. at unity P.F.
Misc. motors, 21 kva. at 70% P.F. lag
Water supply, 475 kva. at 65% P.F. lag
Steam plant, 86 kva. at 65% P.F. lag
Finishing Room, 169 kva. at 77% P.F. lag
Beaters, 242 kva. at 85% P.F. lag
Clay and size, 45 kva. at 50% P.F. lag
Ground wood mill, 980 Kva. at 98% P.F. lag
Power factor circle
3310 Kw.
3310 kva. at 91% P.F.
3170 kva. at 89% P.F.
Bleach plant 182 kva. at 80% P.F. lag
Screening plant 57 kva. at 85% P.F. lag
Wood preparation, sulphite mill 190 kva. at 68% P.F. lag
Wood handling 165 kva. at 50% P.F. lag
Sulphite mill, 450 Kva. at 85% P.F. lag

Fig. 3—Characteristics of the power load in a paper mill.

In this chart the loads on the different feeders running to the various departments of the plant are plotted against reactive and power components. The following characteristics will also be of interest:

Average annual connected load = 4,479 horsepower.
Average annual demand = 4,041 hp.
Average annual load = 2,658 hp.
Annual power consumption = 17,415,712 kw.-hr.
Cost per hp. of average connected load = $15.95.
Cost per hp. of average demand = $17.70.
Cost per hp. of average power = $26.82.
Cost per kw.-hr. = $0.0049 or practically ½ cent.
Annual load factor = 66 per cent.
Annual demand factor = 90 per cent.
Highest peak occurs in July = 5,228 hp.
Highest load factor occurs in Nov. = 78.5 per cent.
Lowest load factor occurs in Mar. = 42 per cent.
Highest demand factor occurs in July =100 per cent.

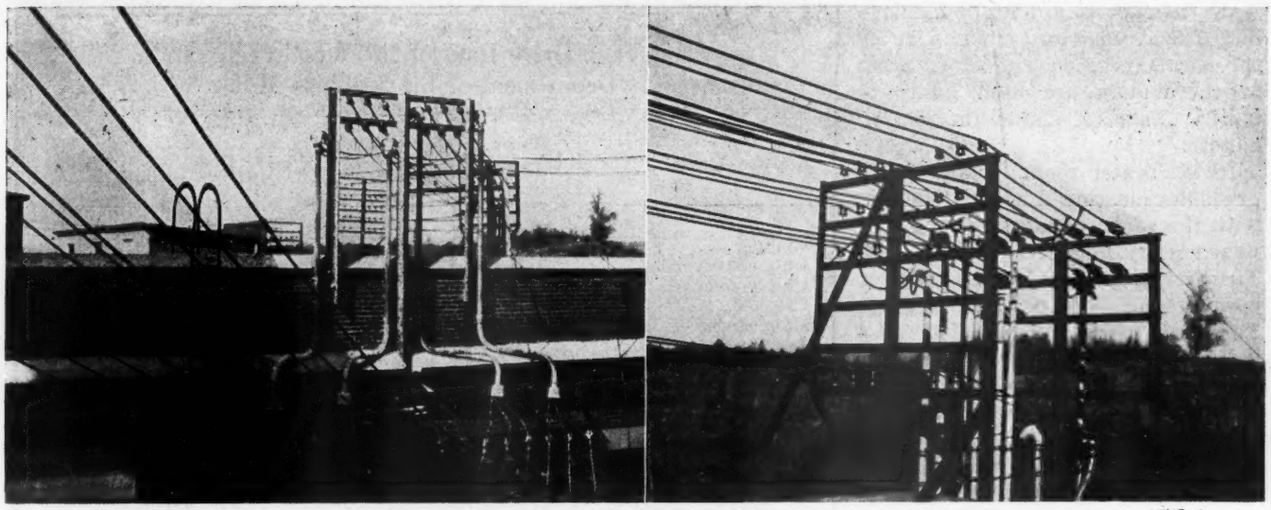


Fig. 4—The feeders to the various departments are carried overhead. The insulators are mounted on steel brackets which are supported on the roofs and walls of the buildings in the manner illustrated in the two pictures. In the illustration at the right is shown how the cables are dead-ended.

The average load of the entire ground-wood mill is 1,290 hp. at 98 per cent lagging power factor. The high power factor is due to the synchronous grinder motor operating at an overload and at high excitation. This motor is direct connected to two 3-pocket grinders and while of ample capacity for a water pressure of 50 lbs. per sq. in., is incapable of carrying the six pockets at the pressure needed to turn out the grade of pulp required. The six pockets are utilized, however, as two are charged with wood while the other four are grinding. The motor driving the grinder is shown in Fig. 8.

Table II—Drive Data of the Wood-Handling Department

Duty	No. of Motors	Type	Hp. Rating	R. P. M.	Drive
No. 1 Log conveyor....	1	S. C.	35	860	Belt
No. 2 Log conveyor....	1	S. C.	50	1,150	Belt
No. 3 Log conveyor....	1	S. C.	15	860	Belt
Portable conveyor.....	1	S. C.	10	600	Belt
Portable conveyor.....	1	S. C.	10	1,200	Belt
Slasher mill.....	1	S. C.	75	860	Belt
Stacker.....	1	S. C.	20	580	Belt
Stacker conveyor.....	1	S. C.	10	600	Belt
Slasher saw.....	1	S. C.	10	600	Chain
Refuse saw.....	1	S. C.	5	1,800	Belt
Splitter.....	1	S. C.	7.5	720	Belt
Total.....	11	.....	247.5	...	....

All of these motors are three-phase, 550-volt, squirrel-cage (S. C.) induction motors.

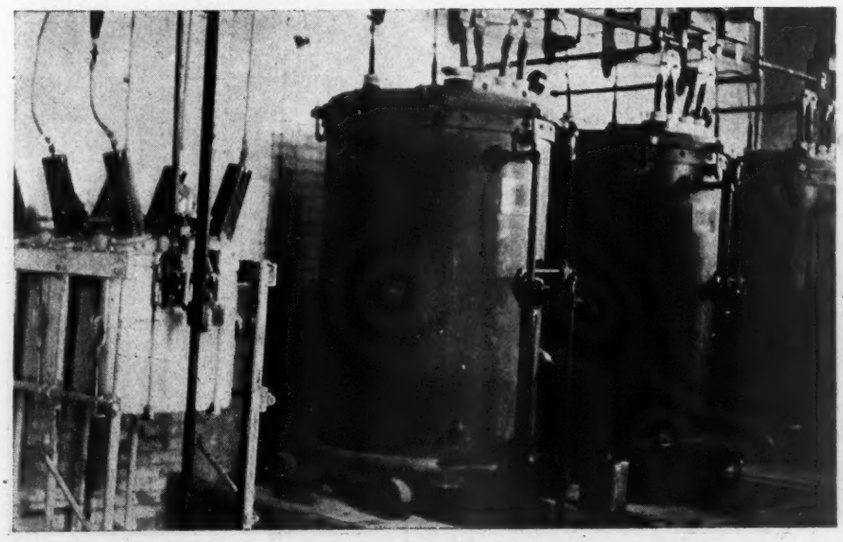


Fig. 5—These transformers step the voltage down from 22,000 volts to 575 volts for use on the various drives throughout the paper mill. The transformers are mounted on trucks and can be moved out from under the bus on a removable track which is not shown in the picture. The removable track section fits in the small recesses in the concrete shown in the lower right-hand corner of the illustration. Each transformer is mounted over a concrete catch basin which connects with the sewer, so that in case of an emergency the oil may be quickly drained.

In the bleach plant, the sulphite and ground-wood pulp are further treated to make the pulp lighter in color. The bleach for the sulphite-pulp is chlorine gas, lime and other chemicals. That for the ground-wood pulp is sulphurous acid. Due to the action of these acids and gases this department is exceptionally severe on motors. The average load is 195 hp. at 80 per cent lagging power factor. Table IX shows the motor list.

Motor Sizes and Type of Drive Used in Book Mill

The present paper mill consists of one book machine with a capacity of 40 tons per 24 hours. This mill is divided into the following departments: clay and size, beater room, machine room and finishing room.

In the clay and size department, all the ingredients that go into a sheet of paper, with the exception of the pulp itself, are mixed. These in-

clude the size, clay, alum and coloring. The average load is 30 hp. at 50 per cent lagging power factor. Most of the motors are used intermittently. Table X shows the list of motors.

In the beater room, all of the ingredients mentioned above, together with the various grades of pulp, are mixed ready for the paper machine. The average load is 275 hp., with a power factor of 85 per cent lagging. Table XI shows the motor list.

Part of the power for the machine room is a.c. and part d.c. The current for the direct-current motors is provided by a 250-volt, 200-kw., steam turbo-generator set. The paper machine is driven by the sectional Harland drive. The average load of the a.c. motors is 660 hp. at unity power factor and the list and ratings of these motors are found in Table XII.

The d.c. generator and motors which make up the Harland drive are separately excited from a 12.5-kw., 125-volt generator. The exciter and generator are both direct connected to the steam turbine through a 5½ to 1 reduction gear, as the speed of the generator and exciter is 900 r.p.m. Table XIII shows the duty and rating of the various sections of the drive. The master section of the sectional drive is shown in Fig. 6 and the couch section is shown in the lower left-hand corner of Fig. 1.

The dry end of the paper machine is equipped with three direct-current motors supplied by a motor-generator set, mentioned later. The list of these motors is given on page 367 in Table XIV.

In the finishing room, the paper is super-calendered, cut into various sizes and wrapped ready for shipment. Part of the motors are a.c. and part d.c. The average power for the a.c. load is 175 hp. at 77 per cent power factor. The list of motors is shown in Table XV.

Fig. 6 shows the layout of one of the super-calenders. There are two of these machines, each operated by a 75-hp. wound-rotor, induction motor. The control is full automatic, with three push button stations for each machine.

The direct-current motors shown in Table XIV as well as those in Table XVI are supplied from a 75-kw., 230-volt, direct-current generator, direct connected to a 110-hp. induction motor. This set, which is shown in Fig. 9, also supplies the excitation

Table III—Drive Data of the Wood-Preparation Department of the Sulphite Mill

Duty	No. of Motors	Type	Hp. Rating	R. P. M.	Drive
Chipper	1	S. C.	100	580	Belt
Chip conveyor	1	S. C.	20	600	Belt
Chip conveyor	1	S. C.	10	600	Belt
Crusher	1	S. C.	20	600	Belt
Chip screen	1	S. C.	20	600	Belt
Log conveyor	1	S. C.	20	600	Belt
Log conveyor	1	S. C.	10	600	Belt
Barking drum	1	S. C.	60	576	Belt
Barking drum	1	S. C.	60	865	Belt
Bark press	1	S. C.	15	860	Belt
Total	10	....	335	...	....

All of the above motors are three-phase, 550-volt, squirrel-cage (S. C.) induction motors.

Table IV—Drive Data of the Acid-Making Department of the Sulphite Mill

Duty	No. of Motors	Type	Hp. Rating	R. P. M.	Drive
Acid pumps	5	S. C.	10	1,800	Direct
Gas fan	1	S. C.	12.5	720	Belt
Gas fan	1*	S. C.	10	1,160	Belt
Rock elevator	1	S. C.	10	1,200	Worm gear
Sulphur elevator	1	S. C.	3	720	Back-geared
Total	9	....	85.5	...	....

*Only used eight hours per week.
The last two items are used intermittently.
All of these motors are three-phase, 550-volt, squirrel-cage (S. C.) induction motors.

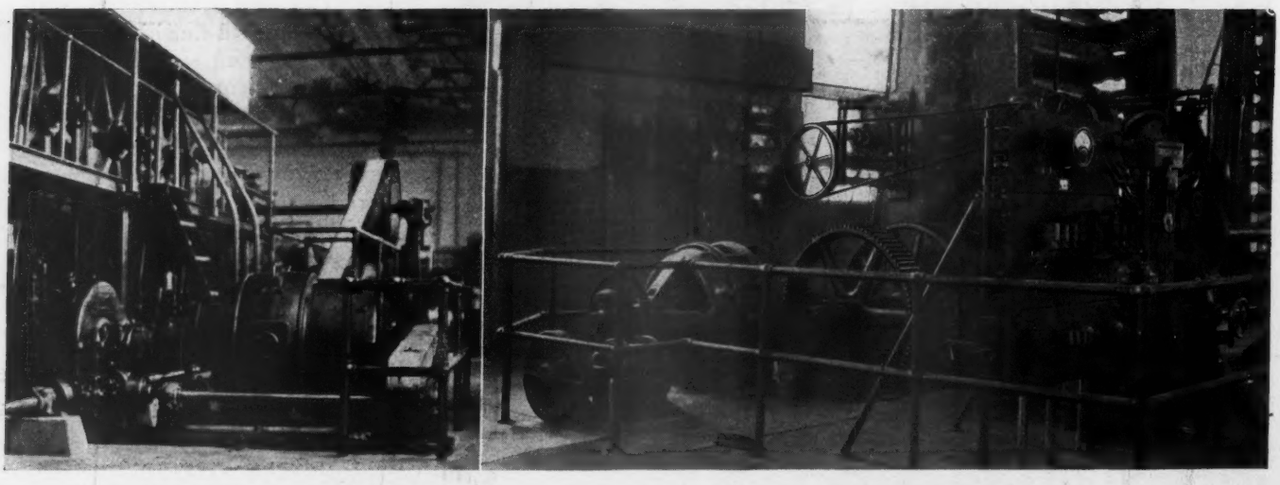


Fig. 6—Sectional paper-machine and super-calender drives.
In the illustration at the left is shown the master section of a sectional paper drive known as a Harland Drive. The illustration at the right shows a super-calender drive together with the full automatic control for it. A 75-hp. wound-rotor induction motor drives the super-calender.

for the Jordan motors. The average load on the motor-generator is 46 hp.

Steam-Plant and Water-Supply Motors and Drives

The motors in the steam plant are used in handling the coal, refuse, fuel and ashes, and for forced draft to the boilers. The list is shown in Table XVII. The average load on these motors is 75 hp. at 65 per cent lagging power factor.

The water used in the mill is pumped from a lake through two water systems: namely, a low-head and a high-head system. The water is pumped from the low-head station to a reservoir in the high-head station, one-third of a mile distant. The average load of the two systems is 415 hp. at 65 per cent lagging power factor. Table XVIII shows the list of motors.

Miscellaneous Motors and Drive Applications

This group is shown in Table XIX. The synchronous condenser is for power factor correction only, and while run continuously, could be dispensed with at times, since the power factor of the system as a whole, is high. If for any reason, the grinder motor or Jordan motors were to be shut down, however, the power factor would drop, and unless the condenser was put on the line immediately, the company would be penalized for low power factor. The actual load taken by this machine is the magnetizing load which amounts to about 50 hp.

Table V—Drive Data of the Sulphite-Pulp Process Department of the Sulphite Mill

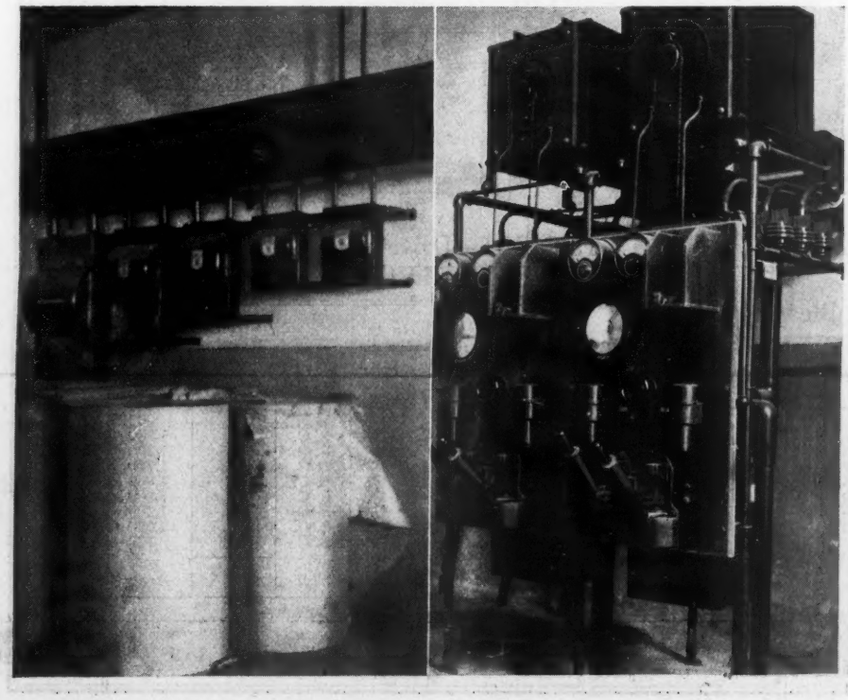
Duty	No. of Motors	Type	Hp. Rating	R. P. M.	Drive
Digester acid pump	1	S. C.	50	1,150	Direct
Booster pump	1	S. C.	40	1,800	Direct
Blower	1*	S. C.	0.3	1,725	Direct
Blow pit pump	1	S. C.	35	1,200	Direct
Knot screen	1	S. C.	35	860	Belt
Freight elevator	1	W. R.	20	860	Worm gear
Wet machines	1	S. C.	37.5	860	Belt
Flat screens	1	W. R.	75	720	Belt
Thickener	1	S. C.	7.5	720	Belt
Agitator and stuff pump	1	S. C.	65	720	Belt
Stock regulator	1*	S. C.	0.1	1,750	Gear
Stock pump	1	S. C.	35	1,200	Direct
Stock pump	1	S. C.	50	1,200	Direct
Save-all	1	S. C.	3	720	Back-geared
Save-all pump	1	S. C.	25	1,800	Direct
Hydraulic presses	1	S. C.	75	860	Belt
Stock agitators	1	S. C.	35	690	Belt
Sulphite packers	1	S. C.	10	720	Belt
Sulphite agitators	1	S. C.	50	720	Belt
Total	19	.....	648.4	...	....

*110-volt, single-phase, induction motors.
All other motors are three-phase, 550-volt, induction motors.
W. R.—wound rotor.
S. C.—squirrel-cage.

Table VI—Drive Data of the Screenings Plant of the Sulphite Mill

Duty	No. of Motors	Type	Hp. Rating	R. P. M.	Drive
Refiner	1	S. C.	50	1,160	Belt
Lap machine	1	S. C.	25	720	Belt
Total	2	.....	75	...	....

All motors are three-phase, 550-volt, squirrel-cage (S. C.) induction motors.



The portable air compressor is used for blowing out motors and keeping up the air pressure on the sprinkler system. It is used about two days a month. The 15-hp. compressor is used only for repair and construction work.

The concrete mixer is also for repair and construction work, and since it has not been used for a period of eight months, is not worth considering as a power load.

The machine-shop motor is used about nine hours a day, seven days per week.

The average load of this group is 70 hp. at unity power factor.

Fig. 7—The feeder is carried from the overhead line to the gutter box inside the building as shown.

From the gutter box, lines are run to the various motors, each line being controlled by a fused safety switch. The illustration at the right shows the control for the 250-hp. synchronous motors on the Jordan engines in the machine room of the *Book Mill*.

Fig. 8—Eight-hundred-horsepower synchronous motor driving two 3-pocket grinders which grind the wood into wood pulp in the ground-wood mill.

In laying out the various motor drives that have just been discussed there are three important points that have to be considered: Service or production is the main feature; maintenance or upkeep is the second; and last and least important is cost.

Factors Governing the Use of Direct Drive

In the paper mills, the forms of drive commonly used are direct drive, gear drive, chain drive and belt drive. All are used, but there is a best place for each.

Table VII—Drive Data of the Wood-Preparation Department of the Ground-Wood Mill

Duty	No. of Motors	Type	Hp. Rating	R. P. M.	Drive
Slasher saw	1	S. C.	50	720	Belt
Disc barker	1	S. C.	10	600	Direct
Log conveyor	1	S. C.	10	720	Belt
Log conveyor	1	S. C.	15	720	Belt
Total	4		85		

All of these motors are three-phase, 550-volt, squirrel-cage (S. C.) induction motors.

Table VIII—Drive Data of Ground-Wood Pulp Process of the Ground-Wood Mill

Duty	No. of Motors	Type	Hp. Rating	R. P. M.	Drive
Grinders	1	Sync.	800	240	Direct
Deckers	1	S. C.	15	720	Belt
Stock pumps	3	S. C.	15	1,200	Direct
Pressure pump	1	S. C.	20	1,800	Direct
Rotary bull-screen	1	S. C.	3	1,200	Belt
Flat screens	1	W. R.	20	720	Belt
Exhaust fan	1	S. C.	1	1,200	Belt
Booster pump	1	S. C.	7.5	1,800	Direct
Agitators and thickeners	1	S. C.	75	720	Belt
Total	11		986.5		

All of these motors are three phase, 550 volt. Sync.—Synchronous motor. S. C.—Squirrel-cage induction motor. W. R.—Wound rotor induction motor

Table IX—Drive Data of the Bleach Plant

Duty	No. of Motors	Type	Hp. Rating	R. P. M.	Drive
Liquor pumps and agitators	1	S. C.	35	1,200	Belt
Strong liquor pump	1	S. C.	7.5	1,800	Direct
Pumps and washers	1	S. C.	75	1,800	Belt
Bellmers	4	S. C.	40	720	Belt
Stock pump	1	S. C.	35	1,200	Direct
Stock pump	1	S. C.	25	1,200	Direct
Agitators and thickeners	1	W. R.	20	720	Belt
Total	10		357.5		

All of these motors are three phase, 550 volt.
S. C.—Squirrel-cage induction motors.
W. R.—Wound-rotor induction motor.

Table X—Drive Data of the Clay and Size Department of the Book Mill

Duty	No. of Motors	Type	Hp. Rating	R. P. M.	Drive
Size pump	1	S. C.	5	1,200	Direct
Clay conveyor	1	S. C.	5	720	Belt
Clay pump	1	S. C.	5	720	Belt
Clay elevator	1	S. C.	7.5	1,200	Direct
Clay conveyor	1	S. C.	15	600	Belt
Clay crusher	1	S. C.	20	600	Belt
Clay agitators	2	S. C.	7.5	720	Direct
Freight elevator	1	S. C.	6.8	1,200	Direct
Total	9		79.3		

All of these motors are three-phase, 550-volt, squirrel-cage (S. C.) motors.

Table XI—Drive Data of the Beater Room in the Book Mill

Duty	No. of Motors	Type	Hp. Rating	R. P. M.	Drive
Beating engines	2	W. R.	125	514	Belt
Triplex stuff pump	1	W. R.	25	720	Belt
Save-all pump	1	S. C.	10	1,200	Direct
Stock regulators	2*	S. C.	0.1	1,750	Gear
Total	6		285.2		

*110-volt, single-phase motors; the remainder are three-phase, 550-volt motors. W.R.—Wound-rotor induction motors. S.C.—Squirrel-cage induction motors.

Table XII—Drive Data of the Machine Room in the Book Mill

Duty	No. of Motors	Type	Hp. Rating	R. P. M.	Drive
Jordan engines	2	Sync.	250	360	Direct
Constant line	1	W. R.	150	600	Belt
White water pump	1	S. C.	35	1,200	Direct
Hood fan	1	S. C.	15	1,200	Direct
Paper slitter	1	S. C.	5	1,720	Belt
Booster pump	1	S. C.	75	1,800	Direct
Hytor pump	1	S. C.	10	1,800	Direct
Calender blower	1	S. C.	10	1,200	Direct
Paper drive blower	1	S. C.	7.5	1,200	Direct
Broke beater	1	S. C.	20	720	Belt
Total	11		827.5		

All of these motors are three phase, 550 volt.
Sync.—Synchronous motors.
W. R.—Wound-rotor induction motors.
S. C.—Squirrel-cage induction motors.

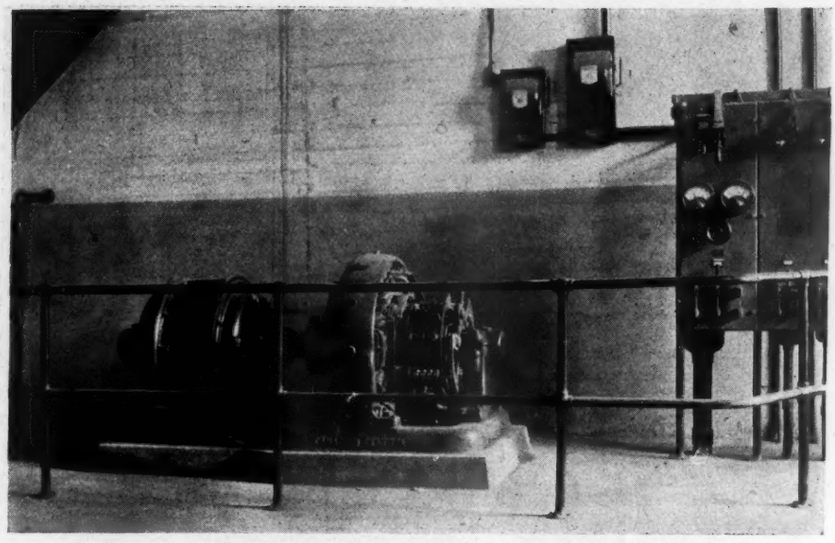


Fig. 9—This 75-hp. motor-generator set supplies the direct-current power for the motors in the dry end as well as the direct-current motors in the finishing end of the machine room in the Book Mill.

By the term direct drive is meant that the motor and the equipment it drives are connected through a coupling, without gears or auxiliary apparatus. It has been found more economical to drive centrifugal pumps by this method, since it not only does away with lineshafting and belts, but also makes the units independent.

In pulp and paper mills, it is no unusual thing to see from eight to ten, and even more motor-driven centrifugal pumps in one room. Some of these may be in line with each other, but more often they are installed to suit the piping layout. If these were driven from a lineshaft, they would necessarily have to be in line; otherwise, countershafting would be necessary. Probably the most important reason for choosing this type of drive is continuity of service. If all of the pumps in one department were driven from a lineshaft by one large motor, all operation and production would cease if a belt broke or came off, or a fuse was blown. With individual units, if one unit shuts down, it only ties up the particular machine the pump is feeding and consequently does not cause a serious production delay.

Another item to consider, but which is not as important as those mentioned, is the question of moisture. Where pumps are delivering and pumping to and from stock tanks, there is more or less liability of the tanks overflowing. Wet pulp in contact with a belt increases the slippage, and it is a common occurrence to have the belt run off the higher-speed pulley and thus interrupt operations.

In the case of plunger pumps, direct drive is not feasible and in most cases impossible, since with double- and triple-acting pumps, the driven pulley is between the pistons. While such a pump could be gear driven it would increase the cost considerably, and for this type of pump, belt drive is more economical.

Aside from centrifugal pumps, there are several other types of machinery with which the use of direct-connected motors is advantageous. For instance, where hand barkers are used, direct drive gives better balance to the barker, saves space, shafting and belting.

In driving fans and blowers, while it is not always possible to connect them directly to the motor, owing to the high rates of speed at which they travel, a fan unit takes up less space with direct drive than with any other type.

In the case of pulp grinders, owing to the (*Continued on page 400*)

Table XIII—Drive Data of the Harland Drive in the Book Mill

Duty	No. of Motors	Type	Hp. Rating	R. P. M.	Drive
Couch	1	Cpd.	55	585/720	Reduction gear
Presses	3	Cpd.	28	500/615	Reduction gear
Dryers	2	Cpd.	55	585/720	Reduction gear
Calenders	2	Cpd.	55	585/720	Reduction gear
Total	8		359		

All of the above motors have forced ventilation.
Cpd.—Compound wound.

Table XIV—Drive Data of the Dry End in the Book Mill

Duty	No. of Motors	Type	Hp. Rating	R. P. M.	Drive
Paper winder	1	Cpd.	20	400/1,200	Belt
Paper hoists	2	Sht.	4	1,100	Direct
Total	3		28		

The above motors are 230-volt, direct-current supplied from a 75-kw. M.G. set.
Cpd.—Compound wound.
Sht.—Shunt wound.

Table XV—A. C. Motors Used in Finishing End of the Book Mill

Duty	No. of Motors	Type	Hp. Rating	R. P. M.	Drive
Freight elevator	1	S. C.	6.8	1,200	Direct
Super-calenders	2	W. R.	75.0	720	Belt
Super-calenders	2	S. C.	10.5	900	Gear
Super-calenders	2	S. C.	3.0	900	Belt
Motor-generator	1	S. C.	110.0	1,200	Direct
Box mill	1	S. C.	7.5	720	Belt
Paper trimmer	1	S. C.	3.0	1,200	Belt
Total	10		303.8		

S. C.—Squirrel-cage induction motor. W. R.—Wound-rotor induction motor.

Table XVI—D. C. Motors Used in Finishing End of the Book Mill

Duty	No. of Motors	Type	Hp. Rating	R. P. M.	Drive
Rewinder	1	Cpd.	15.0	300/1,200	Belt
Sheet cutters	3	Sht.	7.5	450/1,350	Belt
Monorail cranes	2	Sht.	3.5	1,100	Direct
Paper hoist	1	Sht.	4.0	1,050	Direct
Total	7		48.5		

Motors are 230-volt, d. c. Cpd.—Compound wound. Sht.—Shunt wound.

IN THIS ARTICLE Mr. Richards outlines methods that are used to control from the main office the lubrication and inspection of a variety of miscellaneous equipment in nine widely separated bakeries, each of which would be equivalent to a moderate-sized factory. That this plan has worked satisfactorily here is evidenced by the fact that during the more than two years of its operation not a single motor or machine failure has occurred. Similar methods might be applied to moderate-sized factories.

Inspection Routine and Methods of

Controlling Industrial Lubrication

Of Miscellaneous Equipment in Nine Widely Separated Factories Together with a Discussion of Proper Lubricants

By KEENE RICHARDS

Industrial Engineer, Grennan Cake Corporation, Detroit, Mich.

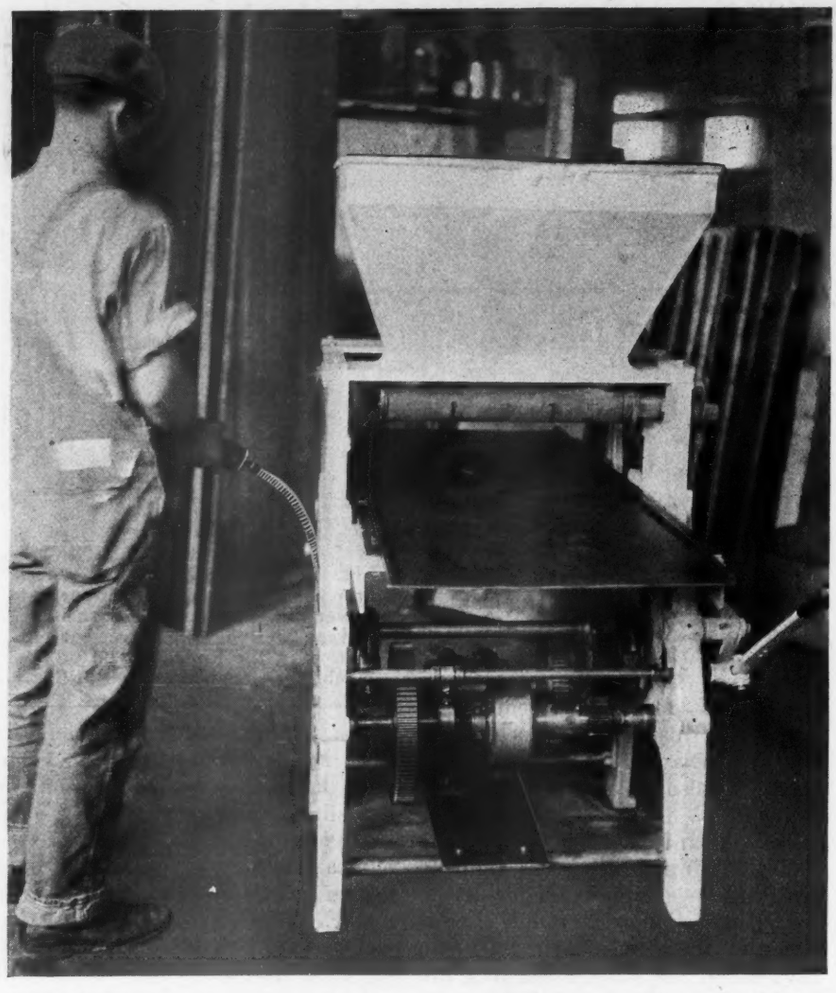


Fig. 1—Wherever possible these machines have been provided with nipples to use in connection with Alemite grease guns.

THE PROBLEM of correct lubrication of machinery and transportation equipment is, beyond question, one of the most important factors in the successful operation of present day industry. The large plant with its resident engineer and local maintenance staff is in the best position to properly solve this problem. However, when a property consists of a number of moderate-sized factories scattered over several states the difficulties of insuring proper lubrication at reasonable expense are greatly increased.

The following method has been in use in the widely separated plants of the Grennan Cake Corporation, located in nine different cities, for more than two years and has proven to be highly satisfactory. The *Engineering Department* is located with the general offices in the Detroit factory. This department has control of technical matters in all plants. In addition to the factory equipment, this department is responsible for the supervision of the maintenance of motor transportation. Machinery is in practically every case driven by individual motors, the majority of which are three-phase. In practically every case the machines are equipped with either variable speed transmissions or gear reductions between the motor and the equipment.

This machinery can be classified in a general way into the following groups:

(1) Machines for the handling of raw materials, such as elevators, conveyors, flour sifters and blenders, and sugar grinders.

(2) Mixing machines. This class of machinery consists of beaters for the mixing and aerating of batter, eggs, icing and other material of a more or less liquid nature. Mixers for the mixing and rubbing of heavy types of dough and special beaters for marshmallow.

(3) Scaling and deposition machines for placing dough in pans, depositing icing on cakes, cutting equipment for the cutting of cake and box forming and filling machinery.

(4) Ovens. These are of either horizontal traveling hearth variety similar to a conveyor, or of the rotary type in which a circular hearth travels in the baking chamber.

The problem of lubrication for each of these types of equipment is quite different. In the first class the conveying equipment offers no particular problem. It is lubricated in general with grease and the ordinary squirt can. In the grinding or chopping machines and the flour handling equipment, the principal difficulty is to keep the raw material, such as powdered sugar and flour, nuts, or other loose material from getting into the bearings. The manner of doing this varies with the type of machine. It is most easily done by keeping the bearing flooded with oil or keeping it under grease pressure so that dust from the machine will not creep into the bearing. In places where the bearings are so arranged that the oil would get into

the product, the only solution, aside from guards, which are more or less ineffectual, is the frequent cleaning of the bearings. Powdered sugar is very difficult to handle from a lubrication standpoint as it rapidly cuts out bearings and converts the lubricant into a sticky granular mess. For this reason the life of bearings in sugar grinders is apt to be short, unless special care is taken in cleaning.

Mixing machinery presents no particular difficulty except the necessary provision made by the manufacturer of the machine to keep the lubricant out of the mixture. The beaters are of the vertical type with the motor mounted at the rear of the machine about 3 ft. above the floor level and driving the machine through spur gearing and transmission which usually allows for three changes in speed. This transmission is lubricated with grease compound, the motor, of course, being ring oiled. The horizontal type of heavy-duty mixer is lubricated either by compression grease cups or drip feed oilers and as this equipment is comparatively slow speed, little or no difficulty is experienced with bearings, although the stuffing boxes though which the main beater shaft passes, occasionally give trouble and if not taken care of properly, will score the shaft.

Machinery in Class 3 is ordinarily of light construction and is lubricated very easily by means of grease gun, grease cup and oil can. Much of this machinery is poorly constructed and inadequate provision is made for bearing adjustment. The illustration at the beginning of this article, Fig. 1, a detail of which is also shown in Figs. 2 and 3, shows how some of the natural difficulties of lubrication due to the construction of the machine may be overcome. On this scaling machine a cam, shown in its lower position, makes the oil opening difficult to get at and somewhat hazardous if it is oiled while the machine is in operation. The grease gun connection is raised above the cam by means of an extension pipe as shown in the detail, Fig. 2. This bearing was particularly difficult to lubricate by ordinary methods.

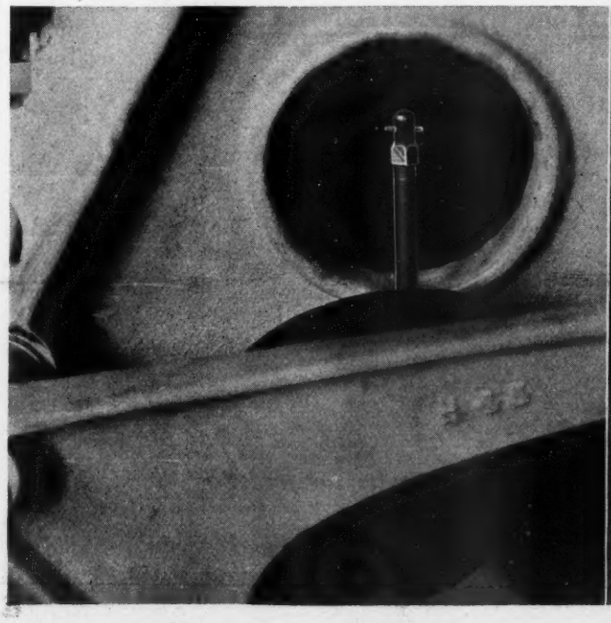
The principal difficulty experienced in lubricating the moving parts of ovens, Class 4, is the high temperature. This is provided for in the character of lubricant used as is noted later. Provision is ordinarily made in the construction of these machines to prevent lubricant getting into the food product handled. Some parts of machines, however, which are directly in contact with food, must be lubricated. This is taken care of by using shortening such as lard or hydrogenated cotton seed oil compound as a lubricant. Whenever equipment is laid up all parts which may come in contact with the product are coated with shortening and the other parts of the machine are doped with grease in the usual manner. It is important that lubricating oil or grease does not come in contact with the material in the machine. This is ordinarily prevented in the construction of the machine by the use of drip rings, felt packing and the placing of bearings so that should they leak, the oil will not drip into the mixing bowl or tank.

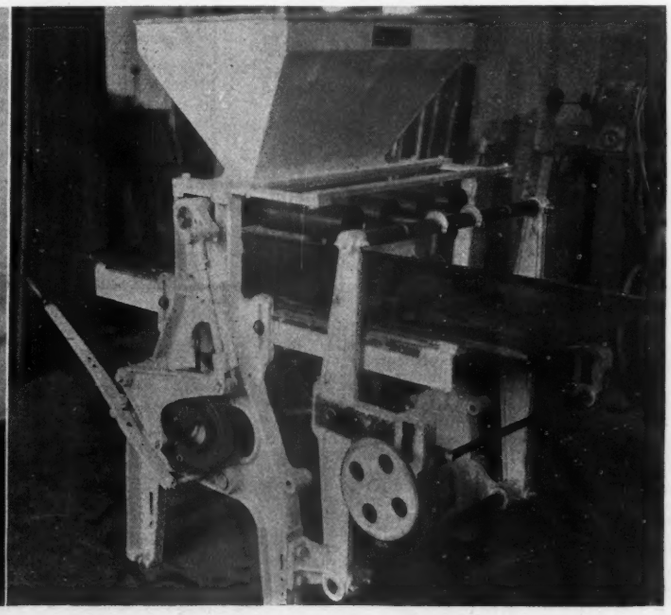
Figs. 2 and 3—These illustrations show more closely the lubrication of the scaling machine in Fig. 1. Because of the cam, as may be seen in the illustration at the right, this was a difficult place to lubricate. The solution was to extend the pipe up from the oil hole as shown at the left and add a nipple for Alemite lubrication. A little thought can often overcome many of the difficulties of properly lubricating equipment.

Machine and Motor Equipment Lubrication Routine

In each plant one man is made directly responsible for the daily lubrication and inspection of all bearings. After coming on duty in the morning this oiler makes a trip through the factory with oil can and grease gun. If the oiler finds anything wrong with the machine he reports it immediately to the factory maintenance man. In the case of the smaller plants the oiler and the maintenance man are frequently the same individual. Immediate attention is given to the trouble and an inspection report made out when the work is finished. It is assumed that an inspection is necessary in order to find the defect and that the inspection is not complete until the remedy has been applied.

Bearings requiring oil, not provided with automatic oiling devices, are lubricated with reclaimed engine oil. This oil is obtained by filtering the oil drained from the crankcases of motor vehicles. No attempt is made to remove the gasoline from this oil as the dilution is not only unobjectionable but is actually beneficial as it reduces the viscosity of the otherwise too heavy motor oil





to a proper degree for light equipment.

Bearings lubricated with oil are generally on the Class 3 type of equipment and consist of small rocker arm shafts, operating infrequently and slow rollers on conveyors, light-duty cams and light eccentrics. Automatic oiling devices in the form of self-contained force feed oilers or the common drip oiler are provided for medium-speed bearings on some forms of horizontal mixers. These, however, in the more modern machines, are being replaced by self-contained, forced-feed oiling systems which keep the bearings flooded with oil. This applies particularly to heavy-duty bread mixers.

Reclaimed oil has been used successfully in electric motors, although it is felt that this service is too important and the duty required too heavy to use reclaimed oil, unless it were possible to test each batch coming from the filter for viscosity, specific gravity and percentage of high-volatile oil present. The oil wells of electric motors and other equipment having ring-oiled bearings are inspected for proper oil level and condition of rings; medium-body motor oil is used in oil wells.

Slow-speed bearings, rocker arms and other miscellaneous points requiring grease lubrication are equipped with nipples and lubricated by means of an Alemite grease gun. This method has been found much superior to the use of the ordinary grease cup. Common cup grease is used in this equipment. Bearings subjected to high temperature, such as main drives for traveling and rotary ovens, are lubricated with graphite grease or a mixture of automobile cylinder oil and graphite. This grease or oil is mixed to suit the particular condition of the individual bearing. Enough graphite is mixed with the cup grease so that it will remain stiff enough to prevent it from flowing from the bearing at the temperature at which it is to be used. Sufficient graphite is mixed with cylinder oil to keep the bearing well coated with graphite even though through inattention or for some other cause such as momentarily increased temperature the oil should evaporate or drain out of the bearing. It is impossible to give proportions used as they vary widely with each type of bearing.

In rotary oven drives which are subjected to a temperature of about 400 deg. the grease merely serves as a means of getting the graphite to the bearing as the grease itself is soon melted out by the high temperature. In some cases oil and graphite are more effective as in any case the graphite is the lubricant. In general, the graphite-grease mixture is used on slow-speed, heavy-duty bearings and the oil-graphite mixture on small bearings of slightly higher speed. Either mixture may be used in the grease gun. In all cases where grease guns are used the bearing is filled with grease daily. A bearing of practically any type which has been giving trouble can very often be kept in service even though it is ordinarily lubricated with oil, by screwing in an Alemite grease cup, filling the grease gun with oil containing about 10 per cent of the finest grade of graphite and then forc-

Location Inspected	Oven #1 Inspected	Electric Inspected	Motor Inspected	Inspection Inspected
2-10-23	10-11-23	6-11-24		
3-10-23	11-10-23			
4-11-23	12-10-23			
5-10-23	1-11-24			
6-11-23	2-11-24			
7-11-23	3-10-24			
8-11-23	4-11-24			
9-11-23	5-10-24			
Motor No. 1567959				Detroit

Fig. 5—Monthly motor inspection reports, Fig. 4, are recorded on this card.

When an inspection report is received at the *Engineering Department* in the Detroit office from any of the nine plants it is entered on the card for that machine. In this way it is easy to check whether any piece of equipment has been overlooked.

PLANT Detroit — GRENNAN CAKE CORPORATION

MOTOR INSPECTION REPORT

To the Industrial Engineer: Date 6-10-24

Electric Motor No. 1709489 Driving Mixer A112

Was on this date inspected and repairs made as noted.

Oil Dirty Oil Rings O.K. Clearance Low

Blownout ✓ Wiped ✓ Brushes None

Commutator or Rings None Leads O.K. Pulley or Gear O.K.

Insulation Poor Starter O.K. Fuses O.K.

Remarks: Insulation in bad condition due to spattering of dough. New cover needed.

APPROVED S.H.A. SUPT. SIGNED G.G. MAINTAINENCE MAN

Form E108

Fig. 4—Monthly inspections and reports are made of all motors and sent to the Detroit office.

Motor inspections are all made by competent electricians. Periodic "spot" checks of these inspection reports are made on various pieces of equipment in the individual plants by the industrial engineer from the Detroit office. A record is taken from the office of the reported conditions and these are checked against the actual conditions found. A detailed report is made to the president of the company of these general plant inspections and the various plant officials have considerable rivalry between them on the rating which they receive as to the condition of their equipment, as found by the industrial engineer on his periodic check-ups.

E 101 3-21-1500

EQUIPMENT RECORD

Article	Cookie Cutting Table. Co. No. A265
Maker	Welded Steel Barrel Co.
Size	4 x 8
Date Purchased	1-2-23 At Detroit
Estimated Life	5 yrs.

Fig. 6—A record of all equipment is kept in the Detroit office.
This shows the manufacturer, the date purchased, the location and probable life. Any extensive repairs, change in location or disposition of this equipment is recorded here.

ing this oil through the bearing, thoroughly flooding it and washing it out. This can be done without shutting down the machine and is particularly effective where a grease bearing has become clogged by the introduction of foreign material, such as dust, into the grease.

Transmissions and gears are lubricated by grease compound similar to common, black, steam-engine cylinder oil. This compound is marketed as Warren Tru-Grease and 600-W. We prefer the first mentioned. This compound is sticky so that it is impossible for gears to plow a channel through the lubricant. In fact this grease is so sticky that it can be wiped from glass only with great difficulty. Gear cases are cleaned out twice yearly and thoroughly flushed with kerosene. Gasoline is not used, due to the fire hazard and because it is believed that it strips the metal completely of its oil film where kerosene itself has some slight lubricating properties and does not entirely destroy the film of lubricant on the surface of the metal. This grease is not worn out at the end of this time but is discarded to insure the removal of particles of metal.

Monthly inspections are made of all electric motors and reports made to the *Engineering Department* in Detroit on the form shown as Fig. 4. Upon receipt in the *Engineering Department*, this report is checked over and its receipt recorded on Fig. 5, which is placed in a card file. If this record shows a motor has not been inspected on time, the superintendent of the plant affected is notified at once. In this way it is impossible for a motor to be overlooked. If the motor inspection report shows indications of overload or any other serious trouble with the motor or machine, an investigation is made immediately and proper steps taken to replace the motor. As an instance, a beater driven by a 3-hp. motor had been running satisfactorily for about two years with no more than the usual inspection. The motor inspection report showed the insulation of this motor gave indications of overheating. An immediate investigation was made which showed that the character of the product mixed in the machine had been so changed as to materially increase the load on the motor. Immediate steps were taken to replace this motor with one of proper size.

All electrical inspections are made by a competent electrician. In the smaller plants where it is not possible to have an electrician as well as a machinist or maintenance man, it has been found advisable to hire an electrician and train him in general maintenance work rather than try to get outside assistance or train the average maintenance man in the care of electrical equipment. We have found that the average competent electrician is generally of higher average intelligence than the so-called all-around mechanic or maintenance man found in most plants.

At this inspection the clearance between the rotor and stator is measured to insure that bearings are not worn down sufficiently to cause cutting of insulation by the rotor. Oil wells are drained, flushed out, refilled and the motor thoroughly cleaned and inspected. Any repairs to insulation, oil rings, or brushes are made at this time.

In case any changes are made on motors, such as replacing leads, brushes or anything of that sort, this is considered as a special inspection and a report made showing the condition found and the condition left as in the regular inspection. Frequent visits are made to all plants by the industrial engineer at which time spot checks are made on various pieces of equipment in the plant. For this purpose a record is taken from the office as to the reported conditions

Figs. 7 and 7A—Motor records are kept on 3-in. by 5-in. cards like this.
Practically all information which may be required about any motor is maintained in the *Engineering Department* of the Detroit Office on these cards. A complete record of repairs or failures is entered on the reverse side of the card, as shown at the right.

GRENNAN CAKE CORPORATION—ENGINEERING DEPARTMENT

Maker Fish Oven Style Rotary Motor Serial No. 1567859
Size
Date Purchased 1-2-23 At Detroit, Mich.,
Estimated Life 10 yrs.
Motor H. P. 1 Make G.E. Speed 1750 Serial No. 1567859
Phase 3 Voltage 220 Diam Shaft 3/4" ~~Pulley~~ or Pinion

Location	Date	Remarks
Fish Oven	1-2-23	Moved from Chicago plant

Machine Oven Rotary Co. No. A-110

REPAIRS AND FAILURES

Date	Time Lost		COST Labor	COST Material
4/15/23	2H 10M	Clutch Jaw Broke	3.60	2.40

which are checked against the actual conditions found. These general plant inspections are in each case followed by a detailed report to the president of the company. There is considerable rivalry between plants as to the rating which they obtain on the condition of their equipment as shown by these reports.

Motors installed vary in size from ½ to 50 hp.; the large majority of motors are, however, 3 and 5 hp. The larger motors are used on ammonia compressors for refrigerating equipment and heavy-duty bread mixers. We have standardized on General Electric or Westinghouse motors and do not accept machinery equipped with any other make. This has been done because it has been necessary to standardize on some particular make in order to simplify repairs. The two manufacturers mentioned are in a position to give us quick service on repair parts and maintain large stocks throughout the country. For these reasons we specify their equipment.

The most frequent repairs made to motors, and indicated as necessary by these inspections, are the cleaning of the motor including the air gap, cleaning of bearings, reinsulation of leads and replacement of bearings. Motor failures before this system was put in operation were principally caused by reduction of air gap due to the wearing down of bearings caused by dirty oil. The air of a factory producing baked goods contains a large amount of flour and sugar dust, which materially shorten the life of high-speed bearings. Proper oiling, cleaning and inspection entirely eliminate this hazard. It is interesting to note in this connection that with these regular inspections there has not been a single motor failure in nine plants, over a period of two years, since this system was put into effect. Previous to that time, motor failures were frequent.

Comprehensive Records Are Kept of All Equipment

In the office of the *Engineering Department* at Detroit a card file, Figs, 6, 7 and 7a, is maintained which records complete data on each electric motor, machine and automobile owned by the company. These cards show the date of purchase, location, size, manufacturer's and company's number and other information. Any extensive repairs or failures are recorded on the back.

These records enable the *Engineering Department* to intelligently recommend the purchase of new equipment, to determine the useful life of machinery, and to draw conclusions as to comparative operating conditions in different plants. Indirectly they serve as a check on the quality of maintenance work done in various factories.

Motor car lubrication is handled in a similar manner. Cars are oiled and greased each night by a competent oiler. Crankcases are drained at the end of each 500 miles, the oil reclaimed by means of a filter and issued for factory lubrication. The crankcase is not washed out with kerosene, as the use of kerosene is decidedly detrimental in that it breaks down the oil film established on the metal of bearings and cylinder walls. The same type of compound is used in rear axles and transmissions as is used in transmissions of machinery in the factory. Each thirty days a complete inspection is made of each car and a report sent to the *Engineering Department* at the main office on the form shown as Fig. 8.

Simple Laboratory Control of Lubrication Purchases

All lubricating oil and grease is purchased on specification. Analyses are made from time to time to see that the quality specified is secured.

This analysis also serves as a check on operating conditions in the factory and in the case of any difficulty with automobile lubrication serves to determine whether crankcase oil is being changed frequently enough. In case of trouble with lubrication of any bearings, whether on motor vehicle or factory machine, a sample of the oil from the bearing, accompanied by a fresh sample of the oil used (*Continued on page 401*)

Form G-102 1m 10-22 GEB

Date ..... Started ..... Stopped ..... Hours Labor .....

CRENNAN CAKE CORPORATION

Car Inspection Report

Car No. .....
Job No. .....
Plant ..... Date of Last Insp. .....

1—Adjust and lubricate front wheel bearings		20—Lubricate brake levers and clevis pins	
2—Test front wheels for alignment		21—Tighten battery terminals, fill battery with water	
3—Change oil in engine		22—Tighten battery clamps	
4—Tighten engine holding down bolts		23—Tighten all electric connections	
5—Tighten and oil hood fittings		24—Tighten gasoline tank	
6—Tighten and oil body bolts		25—Tighten rim bolts	
7—Tighten and oil all fender bolts		26—See that foot and hand throttles open and close carbureter	
8—Tighten windshield anchor bolts			
9—Tighten instrument board bracket bolts and screws		27—See that fan belt is tight and pulley oiled	
10—Test clutch for grabbing and slipping		28—Test gasoline line for leaks	
11—Inspect torque arm and lubricate		29—Test horn	
12—Lubricate clutch control lever and thrust bearing		30—See that generator is charging and oiled	
13—Lubricate transmission		31—See that distributer points are set properly	
14—Lubricate universal joints		32—Adjust and equalize brakes	
15—Lubricate springs		33—See that pedal clear floor boards	
16—Adjust and lubricate spring shackle bolts		34—See that all lights operate	
17—Test and lubricate steering gear		35—See that doors open and close freely and that latches operate	
18—Lubricate differential		36—Test valves, ignition and carburetion	
19—Inspect and adjust motor bearings		37—Fill radiator and gasoline tank	
		38—Clean and polish car for delivery	
		39—Varnish if needed	

REGULAR EQUIPMENT

1—Starting Crank		4—Jack	
2—Keys for switch		5—Rim Tool	
3—Extra rim or wheel		6—Side Curtains	

REPLACEMENTS MADE

Name of Part	Condition Found	Cost of New Part	Disposition of Old Part

Road test of 1 mile made by ..... and operation found satisfactory.

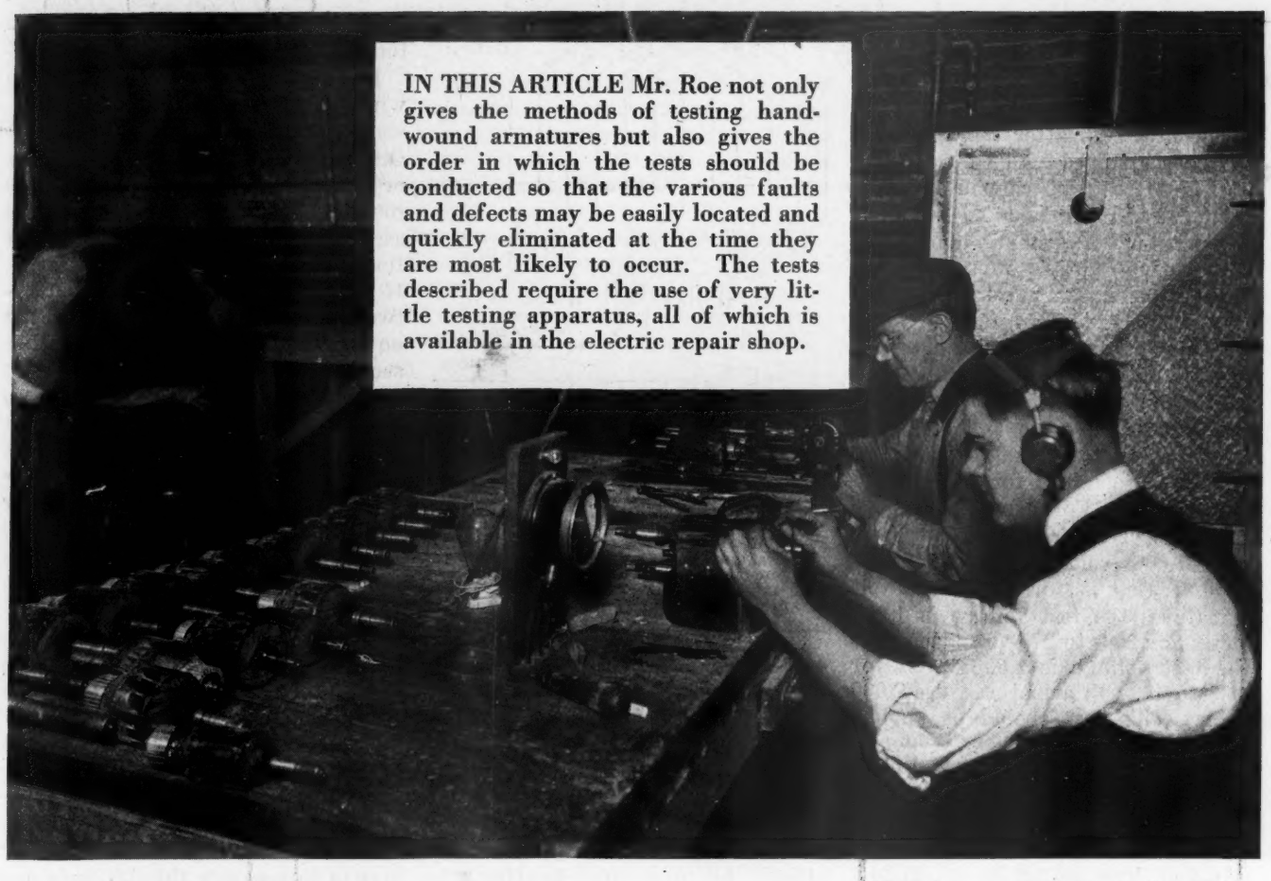
REMARKS:

Signed ..... *Mechanic*

Noted and Filed ..... *Industrial Engineer*

Approved ..... *Supt. Trans.*

Fig. 8—Motor cars of the various plants are also inspected monthly and their condition reported on this blank form.



IN THIS ARTICLE Mr. Roe not only gives the methods of testing hand-wound armatures but also gives the order in which the tests should be conducted so that the various faults and defects may be easily located and quickly eliminated at the time they are most likely to occur. The tests described require the use of very little testing apparatus, all of which is available in the electric repair shop.

Here is an arrangement of a test bench for armature testing.
The millivoltmeter is mounted on an upright wood panel, the test light is a little behind and to one side of it, and the growler is directly in front of the tester.

Some Practical Pointers on the Methods of

Testing Out Armatures During Rewinding

Together with Ways to Locate Shorts and Grounds in Armatures and Commutators Including Methods of Finding Reversed Leads and Shorts Between Coil Turns, Between Top and Bottom Coil Halves and Between Leads

By A. C. ROE

Repair Superintendent, Detroit Service Dept., Westinghouse Electric & Manufacturing Co.

ON HAND-WOUND armatures the wire is wound directly from the wire reel into the slots of the armature. Hand-wound armatures are used in fractional-horsepower motors such as fans, small drills, grinders, starting and lighting units, domestic-appliance motors and the like. In rewinding all types of hand-wound armatures there are a number of defects that can occur, such as grounds, reversed leads, open circuits, and short circuits between bars, between leads, between turns, between top and bottom coils and between coil ends. This last type of short circuit cuts out groups of coils.

In order to detect any of these defects while winding an armature as soon as possible after the defect occurs, it is well to have a procedure of testing that will perform this function. The following method of testing armatures is recommended for use in repair shops rewinding the average range of small armatures:

1. After the armature has been stripped and before winding, test the commutators for grounds and shorts.
2. Wind and wedge the armature.
3. Test for grounds and shorts, using a growler to locate them.
4. Connect the armature and then before soldering leads to the commutator, make a bar-to-bar test using a voltmeter.
5. Solder leads, dip and bake, and turn commutator.
6. Give the armature a final bar-to-bar test.

The reason that a bar-to-bar test is recommended after connecting and before soldering the leads, is that shorts between leads, as well as reversed and crossed leads occur at this stage, and it is easier to raise the leads to locate and remedy the defects when the leads are not soldered. The reason for the test after finishing the armature is that when soldering and turning the commutator particles of solder may run down between the bars at the back of the commutator, thus shorting the bars,

or in turning the commutator the tool may drag small particles of copper across the mica which also shorts the bars.

The first step after the armature has been stripped, and before winding, is to test the commutator for grounds and shorts. To test the commutator for grounds a piece of bare copper wire is wound around the complete commutator, making sure that the wire touches all bars. Apply one test lead to the shaft or core and the other to the wire around the commutator, as shown at *A*, Fig. 2. For armatures up to and including ½ hp., a test to ground of 900 volts, alternating current for one minute is sufficient. For armatures above this size, use twice the line voltage plus 1,000 volts for the test to ground; that is, for 100- to 150-volt armatures the test voltage is 1,200 volts; for 250- to 275-volt armatures the test voltage is 1,500 volts; for 400- to 450-volt armatures, use 2,000 volts. This test should be applied for one minute.

The next step is to test and clear the commutator of shorted bars. This is done with a 110-volt test lamp, putting the leads of the test lamp on adjacent bars as at *B*, in Fig. 2. The carbonized mica will glow or sputter depending upon the resistance of the shorts; in some cases of dead short, the test light will come up to full brilliancy. Most short circuits between bars can be cleared by digging out the dirt and carbonized mica with a knife or ground hacksaw blade. The hole should then be filled with a good commutator cement. A good cement can be made from plaster of paris and shellac. These two ingredients should be mixed together into a thick paste, which can be used to fill the hole in the commutator. Where there are a number of bad spots it will be found more satisfactory to put in all new mica segments or in the smaller sizes of motors, to supply a complete new commutator. The important thing is to be absolutely sure that the commutator is free from all defects before starting to wind.

In rewinding hand-wound armatures, a variety of cores and sizes are received. The condition of the cores varies; some cores are well insulated and others are hard to insulate properly. On some cores the slot or end room is scarce and considerable pounding is required to get the wire into place. When fine wire is used, there is a chance of its breaking; therefore, a 110-volt test lamp should be provided at the winder's bench or winding machine so that the winder can test each coil as he finishes it, thus detecting grounds or opens before passing the defect.

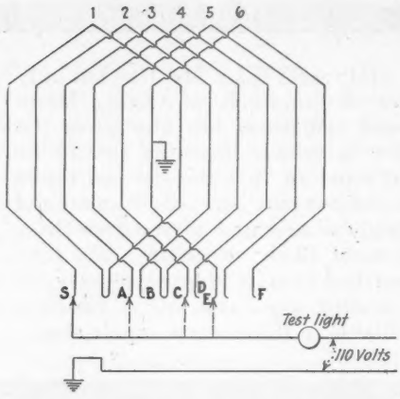


Fig. 1—How to locate grounded lead in straight loop winding, before connecting leads in commutator.

After cutting open the loop *A B*, if the test light glows with test lead on *S*, the ground is in section *S* to *B*. If light remains dark move test lead to *A*, *C*, and *E*, consecutively, cutting open loops about four slots ahead so as to sectionalize winding until grounded section of winding is found, as at *E*.

If the armature shows a ground, after winding and wedging and before connecting the leads to the commutator, the following procedure should be used for locating the grounded coils. There are two cases: one is the straight loop winding in which the wire is not cut from the start to the finish of the winding, and in the other case, each slot has a number of leads projecting from it, half of these leads being top or finishing leads, the others being bottom or starting leads.

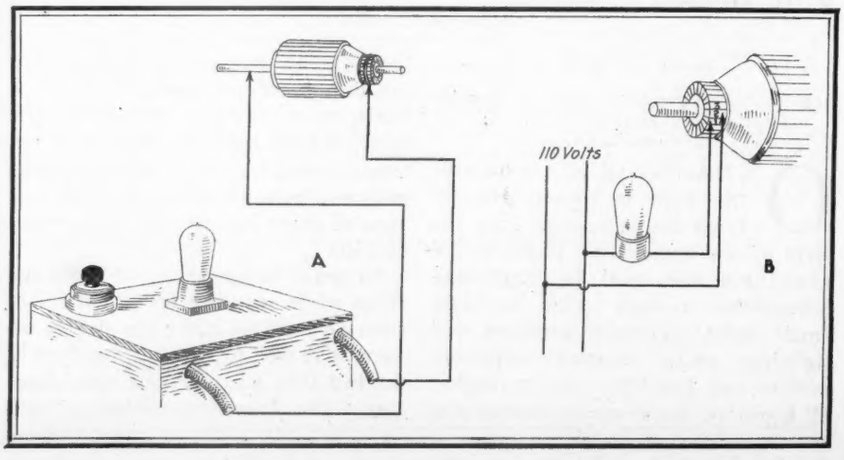
In the case of the straight loop winding, the set-up shown in Fig. 1, should be used to locate the grounds. One test lead is fastened to the core or shaft and the other test lead is touched to one end of the winding as at *S* in Fig. 1. Then a loop about four slots away is cut open as at *B*. If the ground is in the section between *S* and *B*, the test lamp will not go out. If the ground is in the other section of the winding, the circuit will be broken and the light will go out. In this case, touch the test lead to *A*, cut open a loop four slots away, as at *D*. Repeat until the ground is located in a section of four coils, then starting with the first coil of this section, cut open the loops until the grounded coil is found. In Fig. 1, coil 6 is the grounded coil After locating this coil, the remainder of the loop winding should be tested to make sure that there is only one defective coil.

In the other case referred to, each slot has a number of leads projecting from it, half of them being top or finishing leads, the other half being bottom or starting leads. The first step is to separate the top leads and bend them back, toward, but not touching the core. The bottom lead should be pulled out straight and about ¼ in. of the insulation should be removed from the end of each lead. Then tie the leads together into separate bunches by pieces of bare copper wire and apply high voltage between each of these bunches and ground. One of these bunches of wire will show a ground. Remove the tie wire from the bunch that shows a ground and test each lead separately with a test lamp, one lead of which is on ground, until the grounded coil is found.

If the winding is tested for grounds after wedging and before

Fig. 2—To test a commutator for grounds, wrap a bare copper wire completely around it, making sure that the wire touches all bars.

This test is shown at *A*. Apply one test lead of the testing transformer to the shaft or core and the other to the wire around the commutator. At *B* is shown the method of testing a commutator for shorts between bars. This is done by putting a 110-volt test light in series with one lead from the power supply and applying the leads to adjacent commutator bars. If the bars are shorted the light will glow.



connecting to the commutator, the finished armature should be clear from grounds. However, if the winding shows a ground after connecting the leads to the commutator, the following method will locate the defect.

The set-up for this test is shown in Fig. 4. The test line with a lamp bank in series with it is connected to bars directly opposite, as at *1* and *10*. With a millivoltmeter on two adjacent bars at *2* and *3* adjust the lamp bank until approximately one-quarter scale reading is obtained on the meter. Then remove the millivoltmeter leads from bars *2* and *3* and connect one lead to the core as shown. With the other lead touch the commutator at a point midway between the two line leads, as bar *4*. Make this connection lightly and quickly, watching the meter scale. If the pointer of the meter goes off the scale try bar *5*, bar *6*, *etc.* If this does not bring the pointer down on the scale, try bars on the opposite side of bar *4*. The reason for the high reading when the meter leads are touched to bar *4* is as follows: Coils *1, 2, 3, 4, 5, 6, 7, 8* and part of *9* are in series to ground; hence the meter measures the drop across the series of coils between bar *4* and ground. When the meter lead is moved to bar *5*, as at *C*, the drop is reduced by one coil. As the lead is moved toward the bar to which the grounded coil connects, the meter readings will become lower until bar *9* is touched. This will give the lowest reading. If bar *10* is touched the reading will become larger. Decreasing readings indicate that the grounded coil is being approached while increasing readings denote that we are working away from the defective coil.

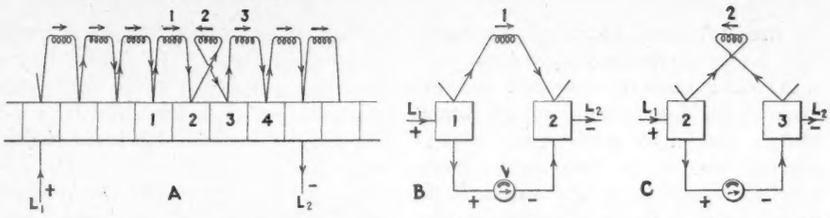


Fig. 3—Case of reversed leads that will not show up with the drop-of-potential or millivoltmeter test.

In diagram *A* is shown the connections for the ordinary millivoltmeter test. Current goes in commutator at L_1 and out at L_2. The current goes in the same direction through all the coils except coil *2*. With the millivoltmeter across bars *1* and *2* as shown in diagram *B* a deflection will be obtained. With the millivoltmeter across bars *2* and *3* as shown in diagram *C*, a deflection in the same direction will be obtained. Although the current through the coil is reversed, the millivoltmeter reads the same as in the case of coil *1* because it merely measures the drop of potential across the coil and not the current passing through it. The correct way to locate reversed leads is by the use of a compass as explained in the text.

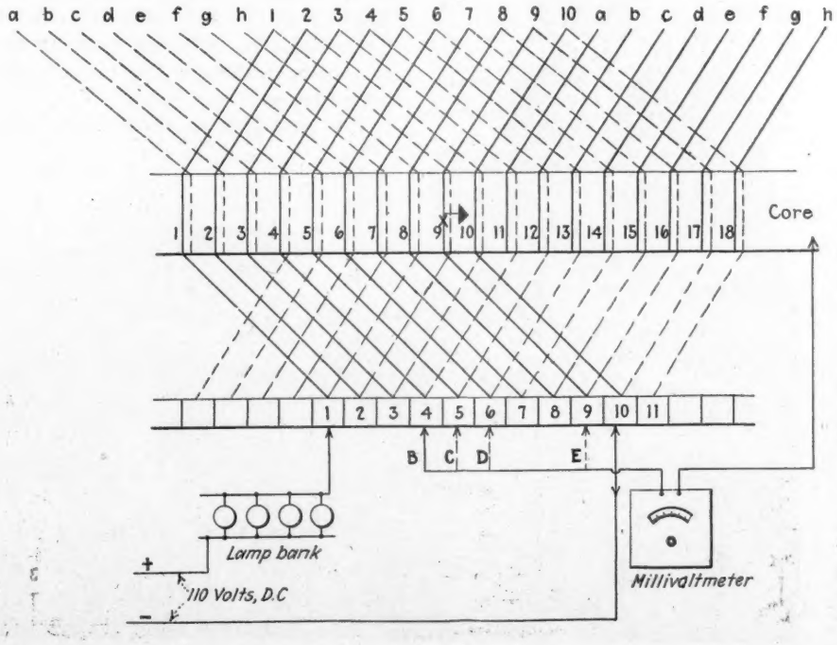
After locating the grounded coil in the manner just described, test it by disconnecting from the commutator the top lead of the grounded coil and a lead on each side of this lead. Test the coil to ground and also the other section of the winding to make sure that all grounds have been located. A telephone receiver can be used in the test described, in place of the millivoltmeter. A loud noise in the telephone receiver corresponds to a high meter reading.

Reversed or crossed leads often occur while connecting the leads to the commutator; hence these defects should be located before soldering the commutator connections. There are two cases of reversed leads: In one case a voltmeter will show up the fault; in the other case it will not. In diagrams *A*, *B* and *C* of Fig. 3 is shown a reversed coil or a case in which the top and bottom leads have been interchanged. In diagram *A*, the flow of current from the test leads L_1 and L_2 is from left to right through all the coils except coil *2*, over which the arrow is shown reversed. The only way in which this type of reversed lead can be detected is by means of a compass.

Inspection of diagrams *B* and *C*, Fig. 3, will show that a voltmeter or telephone receiver will not locate this fault. Using a millivoltmeter in the bar-to-bar test, as in diagram *B* of Fig. 3, place the millivoltmeter leads on bars *1* and *2*. This measures the drop over one coil, the direction of the flow of current being indicated by the arrow through the meter in the diagram. With the millivoltmeter leads on bars *2* and *3* as shown in diagram *C*, the drop over coil *2* is measured. In this case, the current through coil *2* is reversed, but the flow through the meter remains the same; therefore, there is no indication of trouble. If an armature with a coil in this condition were put in a motor frame and run, the coil would cause sparking every time it passed from under the brush. The correct way to locate this kind of a defect is to place a compass over the armature slot while direct current is being passed through the windings. The armature should be revolved slowly and as the slot having the defective coil passes under the compass, the compass needle will reverse. This trouble can be caused by the winder putting on the wrong colored sleeve

Fig. 4—Locating a ground by using a lamp bank and a millivoltmeter.

The millivoltmeter is first placed across two adjacent bars, as bars *2* and *3*, and the lamp bank adjusted so as to permit current enough to pass through the winding to give a quarter-scale deflection on the millivoltmeter. One lead of the millivoltmeter is then grounded to the core as shown and the other test lead is successively connected to commutator bars *4*, *5*, *6*, etc., as at *B*, *C*, *D*, respectively. As the bar to which the grounded coil is connected is approached the millivoltmeter readings will decrease and as we work away from the grounded coil the readings will increase. The lowest reading indicates the bar to which the grounded coil is connected.



on the start and finish of one coil; that is, by interchanging colors.

Another case of reversed coil or crossed leads occurs in loop windings and is caused by putting the wrong colored sleeves on two loops. This case is shown in diagrams *A*, *B*, *C* and *D* of Fig. 6. In diagram *A*, the bottom lead of coil *1* and the top lead of coil *2* have been connected to bar *3*, and the bottom lead of coil *2* and top lead of coil *3* have been connected to bar *2*. This reverses coil *2* as is shown by the arrows over each coil. When making a bar-to-bar test with the millivoltmeter leads on bars *x* and *1*, the drop over one coil (coil *x*) will be obtained. Call this a normal reading. When the meter leads are put on bars *1* and *2*, a reading that is twice normal will be obtained, but the pointer will point in the same direction. Diagram *B* shows the reason for this double reading. The top lead of coil *1* connects to bar *1*, and its bottom lead to bar *3;* the top lead of coil *2* also connects to bar *3*, and the bottom lead of coil *2* is connected to bar *2*. Hence, coils *1* and *2* are in series between bars *1* and *2*. When the millivoltmeter leads are placed on bars *2* and *3* as in diagram *C*, the drop of one coil (coil *2*) is measured and a normal reading is obtained, but the pointer points in the opposite direction. The reason for the reversed reading is that the lead of coil *1* makes bar *3* positive, just as if L_1 were directly attached to bar *3*. When the millivoltmeter leads are put on bars *3* and *4*, as in diagram *D*, a reading of twice the normal amount and in the correct direction will be obtained. This is because coils *2* and *3* are in series between bars *3* and *4*. Hence, when making a bar-to-bar test, this type of defect is indicated by obtaining the following sequence of readings: first a double reading, then a normal but reversed reading and finally, a double reading in the proper direction. A telephone receiver would give a high, followed by a low, and finally a high sound. The meter is more accurate, however, as it gives one more indication; that is, the direction of the current flow.

The remaining types of defects that are likely to occur while winding and connecting armatures, are short circuits. Each type of short circuit has different characteristics and different methods must be used for locating them. The most common short circuit is a short between turns; that is, when one or more turns form a closed circuit. This

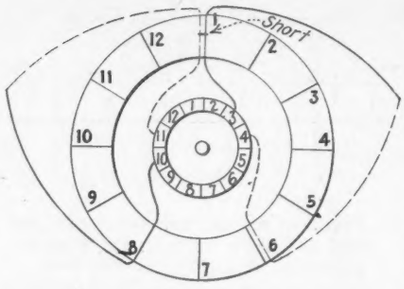


Fig. 5—Method of locating short that occurred between top and bottom halves of coils in the same slot.

In the growler test the tin keeper was attracted in slots *1*, *6* and *8*. The coil pitch of the winding shown is 1-and-6. Take any slot which has shown signs of being shorted in the growler test, for instance slot *1*. Then count each way from this slot a distance equal to one coil pitch and if the two slots reached are the remaining ones that showed signs of being shorted from the growler test, the two coils are shorted together in the slots from which the count was started. Counting a coil pitch each way from slot *1* we reach slots *6* and *8* which were the other two slots which showed signs of being shorted; hence the short between the two coils must be in slot *1*.

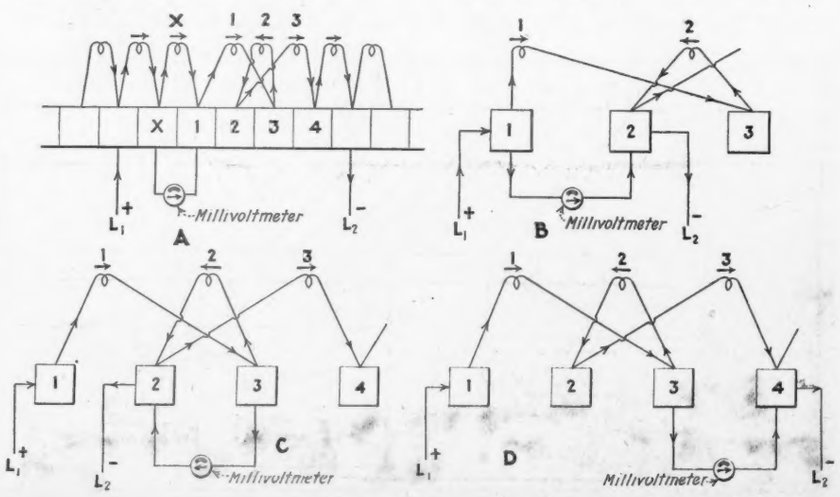
affects only one coil. Using a millivoltmeter in the bar-to-bar or drop-of-potential method of testing, a short circuit between turns in a coil will give a lower than normal reading on the millivoltmeter scale. The magnitude of the reading depends upon the amount of the coil that is shorted out. A zero reading will be obtained when the coil is completely short circuited, in other words a dead short.

The best method of locating shorted coils is to use a growler. An armature should be tested for short circuits by means of a growler after winding and wedging and before connecting the commutator leads to the commutator. Then any shorts that show up after connecting are either in the commutator leads or in the commutator. When using the growler, shorts between turns will cause the metal keeper to be attracted to two slots; that is, the slots in which the top and bottom halves of each coil lie. By studying the effect of each type of short separately, it soon becomes easy to determine and locate any shorts that may occur in the winding. For example, assume a 14-slot armature, coil pitch 1-and-7 and that the growler test shows signs of shorts in four slots. Assuming that the coil turns are shorted and that the slots marked from the growler test are spaced 1, 4, 7, and 10, then slots *1* and *7* contain one coil and slots *4* and *10* contain the second coil. The coil pitch and what can be seen of the coil helps to locate the bad coil. With the bar-to-bar test the millivoltmeter will give a low reading when it reaches the two bars to which the lead of the shorted coil connects. This locates the coil without any further test. Shorts between coils in the same cell in a loop winding would come under the head of shorted turns, although the shorts are between coils, and if the two loops from the slot were cut open a light would be obtained between the two coils, although the circuit had been broken.

The next type of short is one that

Fig. 6—Another case of reversed coil leads that sometimes occurs in loop windings.

This condition is shown in diagram *A*. On passing a current through the winding and with the millivoltmeter leads across bars *x* and *1* as shown in diagram *A*, a normal deflection will be obtained on the meter. With the meter leads on bars *1* and *2* as shown in diagram *B*, a reading twice normal will be obtained, because the meter is across coils *1* and *2* in series. With the meter leads on bars *2* and *3* as shown in diagram *C* a reversed reading will be obtained. The reason for the reversed reading is that the lead of coil *1* makes bar *3* positive just as if L_1 were directly attached to bar *3*. When the meter leads are placed on bars *3* and *4* as shown in diagram *D* a reading twice normal and in the correct direction will be obtained. This is because the meter is measuring the drop of potential over coils *2* and *3* in series.



occurs between top and bottom halves of coils in the same slot; this is commonly called a short between top and bottom coils. This is done to distinguish this type of short from the short between the coils in the same cell in a loop winding. This type of short forms a closed path, similar to a figure 8 and will affect two and three slots, depending upon the type of winding and the coil pitch. With a diametrically-split winding, two slots directly opposite would be affected. With the chorded-loop, split-loop, and split-V-loop windings, three slots would be affected. To find the slot in which the short is located, take any one slot that the growler shows as shorted and calling this slot No. 1, count over to the right and to the left a distance equal to one coil pitch. Then if each count falls on a marked slot as shown from the growler test, the short is in the slot called No. 1, but if the count does not fall on a marked slot on both sides, take any other marked slot and call it No. 1 and repeat the right and left count. This method is shown in Fig. 5. With the bar-to-bar test, a low reading will be obtained between bars *10* and *11*, and *3* and *4*, but this would not indicate anything more than that there were two shorts in the winding. From the above, it is obvious that the growler is the best means of detecting and locating shorts. The growler will also show whether a short is in the winding, or in the commutator. If two commutator bars show up as being shorted from the millivoltmeter test, put the armature on a growler and bridge the two bars with a knife, taking care that the coil to which these bars connect is in the active field of the growler. Then break contact with one bar. If a spark is seen at the time of breaking contact, the short is in the winding; if no spark is obtained, then the two bars are shorted and the trouble is in the commutator.

Shorts between leads occur mostly on armatures that are wound with more than one wire in hand and in which more than one wire is used per sleeve. Shorts of this kind are caused by the wires in the sleeve getting twisted. When pounded on while connecting, the insulation is broken, thus shorting the two coils. This acts the same as a short between turns.

This trouble occurs mostly in the top layer of leads, for the bottom leads are usually put down as they come from the slot. The top leads have to be twisted and interchanged and sometimes the twist is pulled back close to the core. The very act of pulling the twist tight often results in a short. This type of short is one that occurs between coil ends on any type of hand winding and is the hardest type of short to locate because one coil in crossing the end of the core from slot to slot, passes over a number of other coils, both top halves and bottom halves. There is no regularity about the occurrence of the attracted slot or bars when using the growler. A number of slots will show signs of shorts and they cannot be reduced to a regular order as explained previously. You can be sure that the trouble is between coil ends, sometimes, by moving the end windings with the hand. If the trouble can be made to disappear and reappear, this proves where the trouble is, but if this method fails the following will locate the trouble: Remove all the top leads; then take a test light and attach one lead of the test circuit to any one top lead with a piece of bare, copper tie wire. Have this wire long enough to reach around the commutator. Then with the other test lead touch the top lead adjacent to the one to which the first test lead is permanently attached. If a light is obtained, it indicates a short between these two coils. In this case, tie the two leads together with the tie wire and at the same time mark both leads so they can be found later. If no light is obtained, tie both top leads together with the tie wire without marking the leads. Then touch the test leads to the next top lead. After this tie this lead to the first two leads by the tie wire. Repeat this process with each top lead until the starting point is reached, marking every top lead that shows a light. These marked leads are the ones that connect to the coil shorted across the coil ends. With a bar-to-bar test, all kinds of readings would be obtained on the millivoltmeter, depending on the degree of contact and the number of places shorted. No definite results would be obtained with a bar-to-bar test in this case.

The foregoing discussion applies to hand-wound armatures only, that are being rewound. When a number of troubles show up in a winding and they give trouble in locating it will be found the best policy is to strip and rewind the armature completely.

From the above, it follows that with the drop-of-potential or bar-to-bar test, a short circuit in a coil will give *(Continued on page 401)*

Fig. 7—Using a growler to test a small armature for shorts.
If the tin keeper which is placed over the top slot is attracted, the coil in that slot is defective. In the foreground at the left is a portable testing transformer which is used for testing the winding and commutator for grounds.

WITH THE ENLARGEMENT of existing departments or the addition of new ones and the increasing use of power service, the original distribution system of a factory or institution often becomes inadequate. Unless the necessary additions to the system are well planned and carefully installed, the result is a system which is cumbersome, inefficient and perhaps hazardous from fire and safety standpoints. In this article, Mr. Fritz describes a distribution system, in which safety for operators and reliability of service were prime considerations, that was installed in a California state institution for the insane.

Some Practical Details on

Changes In a Distribution System

Which Have Lowered Maintenance Costs, Cut Fire and Accident Hazards and Increased Reliability of Service

This shows the high-tension oil switches and disconnects, in the main substation, for the outgoing 2,400-volt lines.

By B. R. FRITZ

Foreman Electrician, Department of Public Works, State of California.

RECENTLY I was called upon to do the field work in laying out and making recommendations for the installation of a distributing system for the Napa state hospital. This is the largest of six similar institutions for the care of the insane. At the present time there are about 3,000 inmates in the institution proper, which covers a great many acres of ground. Two large ranches are operated in connection with it and it is, on the whole, as nearly self-supporting as possible.

A thorough inspection of the existing installation showed that it had been outgrown and was inadequate for the demands placed on it. As the institution had grown, new circuits had been run from time to time to meet changing conditions. Much of this work was poorly done and as a result make-shift wiring was everywhere in evidence. It was not only a serious fire hazard, but was also dangerous from the standpoint of personal safety. As an example of the conditions, the main building was supplied by a power company with current at 2,400 volts. This was stepped down to 220 volts, three-phase, and 220 volts and 110 volts, single phase, at three different places in the basement. The power company had twenty-one meters to measure the current used and nearly a day was required to read all of these meters.

It was plainly evident that any attempt to revamp the existing installation would be very difficult and expensive. Recommendations were made, therefore, to abandon entirely the existing installation and put in a complete underground distribution system, as this would eliminate almost entirely the fire and personal injury hazards.

In the new installation, electrical energy is delivered at 2,400 volts, three phase, by the power company from its hydro-electric generating station in the Sierra-Nevada mountains over a main cable consisting of three No. 0 varnished-cambric cables. This cable terminates in the main sub-station, which is built of brick and concrete. The primary board shown in Fig. 1, is located in this substation and consists of one metering panel on which all of the energy used is measured both by the power company and by the institution, one panel with oil switch, voltmeter and voltmeter receptacle, and five panels with oil switches for the out-going, 2,400-volt feeders to

Fig. 2—The trough system of wiring was used for the switchboard which controls the motors in the laundry.

Push-button control is used for the motors in this department. This switchboard, which consists of the starters and enclosed line switches, was mounted 7 ft. above the floor. The main switch alone can be operated from the floor. The troughs for the wiring were made of No. 14 galvanized iron; the covers are made in sections and are fastened with machine screws.

the various distribution points. A recording watt-hour meter is installed on the meter panel for use in making rates. Also, above one of these out-going panels is located a ground detector of the electrostatic type. Some time ago a storm put the power company's ground detector out of service and for a short period all trouble on their lines was located from this station.

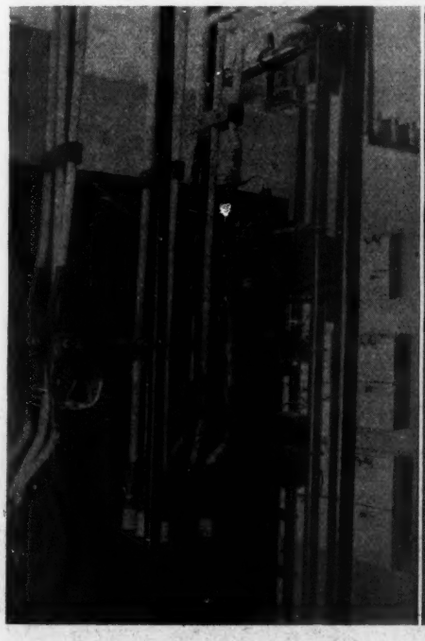
Behind the primary board is located the primary rack where all of the out-going primary lines are fed through the oil switches and disconnects which have 90-deg. stops and are used to isolate the oil circuit breakers and equipment so that they may be worked upon with absolute safety. These disconnects are mounted 8 ft. above the floor, as shown in the illustration at the beginning of this article. All of the primary lines leave the racks through a three-conductor pothead, leading to the primary pit, from which they go to the main manhole which is located in the center of the road in front of the substation.

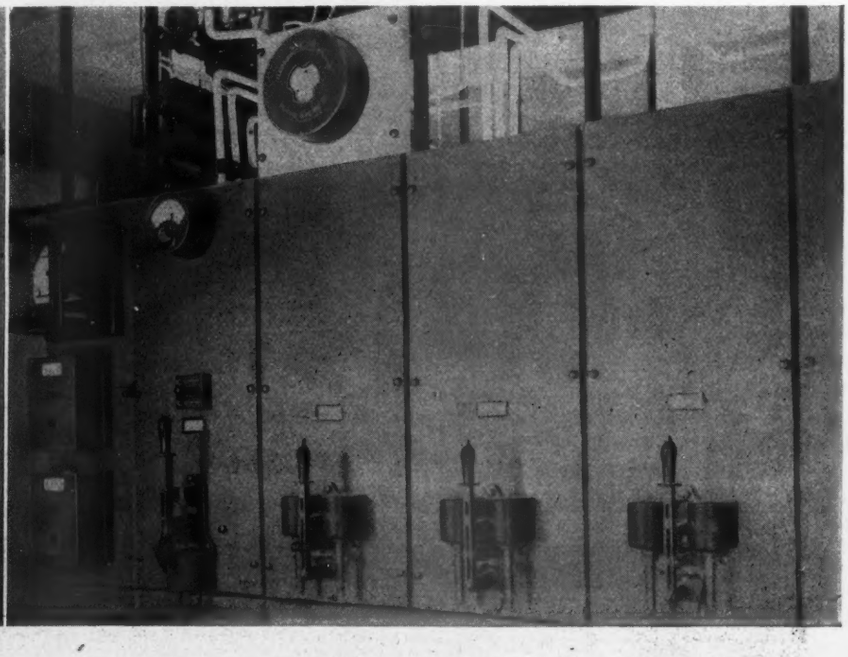
The secondary board is placed at a right angle to the primary board and is of the safety first type (see Fig. 4, *B*). This board also has a pit behind it where all of the low-voltage cables are brought in. This pit and the primary pit as well have covers made of ¼-in. steel plates, but are not inter-connected. The secondary board is fed from a closed-delta bank of transformers consisting of one 150-kva. and two 50-kva transformers. The lighting circuits in this vicinity are taken from one of these transformers. All of the cables behind the secondary board were taped and treated with water glass. The secondary buses from the transformers are made of 3/16-in. x 2-in. copper and, as will be seen from Fig. 4, *A*, are suspended 8 ft. above the floor on a pipe framework. This construction makes it easy to remove a transformer in case of a burnout. In front of the transformers is a pit which is connected with the sewer and is capable of holding all of the oil from one transformer.

Fig 1—High-tension switchboard in main substation.

The primary board, shown at the right, consists of a meter panel, a voltmeter and main oil switch panel, and five panels on which are mounted oil switches for the 2,400-volt lines going to the various buildings and departments. The electrostatic ground detector can be seen at the top of the third panel from the left. The small photograph at the left shows the rear of the meter panel.

This substation also feeds another substation which is located near the water-pumping plant, which has a connected load of 250 hp. This pumping plant substation, a view of which is shown in Fig. 4, *C*, has three, 75-kva., transformers which step the voltage down from 2,400 volts to 220 volts, three-phase. Inas-





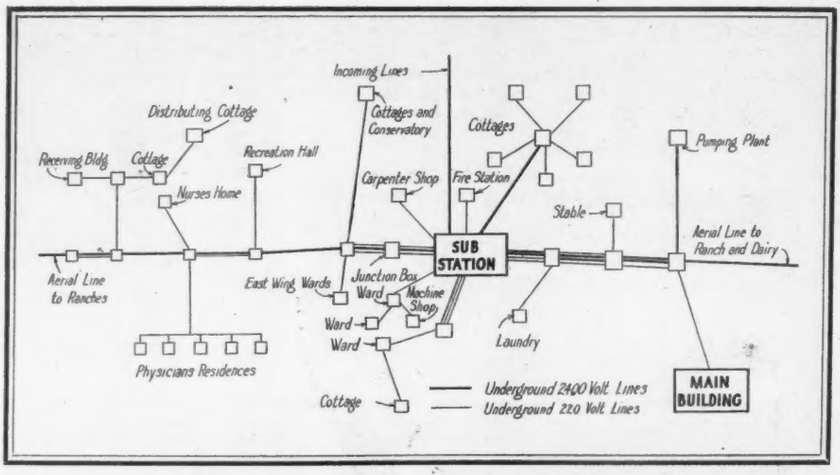


Fig. 3—Single-line diagram showing location of buildings and high- and low-tension feeders.

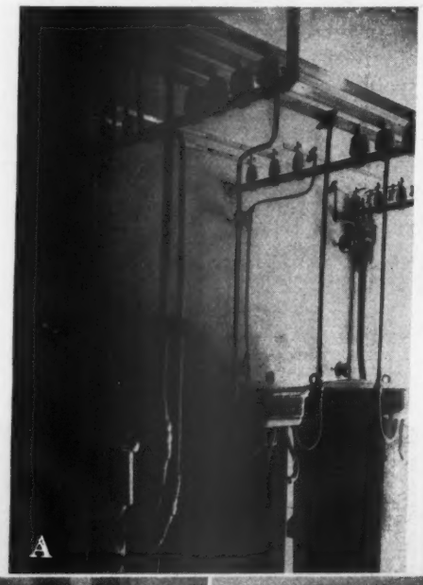
much as the low-voltage motors draw a heavy current, costly bus work was avoided by running two 500,000 circ. mil cables from each transformer to a pull can, located on the pump house wall back of the transformers, where the delta was closed. Besides the saving in cost, this construction gives a greater current-carrying capacity than if the delta had been closed directly at transformers and three 1,000,000 circ. mil cables run in.

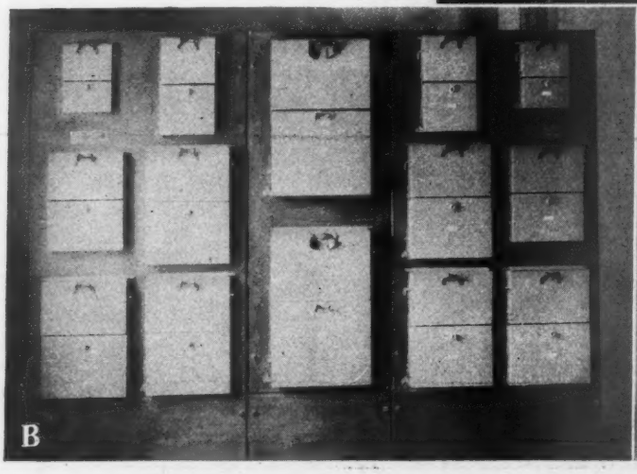
The installation of the electrical equipment in the pumping plant was very carefully planned and carried out. There is no exposed wiring and every precaution was taken to insure maximum safety to the operator and reliability of operation. At this pumping plant the water is raised by air from wells which are 350 ft. deep. From the wells the water is discharged into a large concrete pit from which it is pumped under pressure into the water mains.

The laundry, which is another power-using department, is fed from the main substation through a 350,000 circ. mil 3-conductor cable with a weatherproof No. 00 neutral. Owing to the fact that some of the patients in the institution work in the laundry and in the bakery, special precautions had to be taken in locating the electrical equipment so as to make it as nearly fool-proof and free from the possibility of interference as can be. In fact, this condition was given prime consideration in the installation of all the equipment in the institution. For this reason, these two buildings were completely re-wired throughout.

The switchboard, Fig. 2, which contains Trumbull enclosed, externally-operated knife switches and the motor starters, was placed 7 ft. above the floor on a platform, with the main switch on the floor level. Nearly all of the motors are suspended from the ceiling, being bolted to steel I-beams. A few small motors, properly guarded, are mounted on or near the machines which they drive. All of the machines in the laundry are belt-driven. All motors have conduit terminals and are started and stopped by push buttons, so that in case of accident the foreman needs to step but a few feet to shut off all power. With the manually controlled starters previously used, the patients were continually blowing fuses and causing annoying delays.

The power factor of the laundry had previously been very low; so the writer put a recording watt-hour meter on all of the motors. As a result of these tests, one 25-hp. motor was replaced by a 15-hp. motor and smaller motors were put on several machines, making individual drives. *(Continued on page 403)*





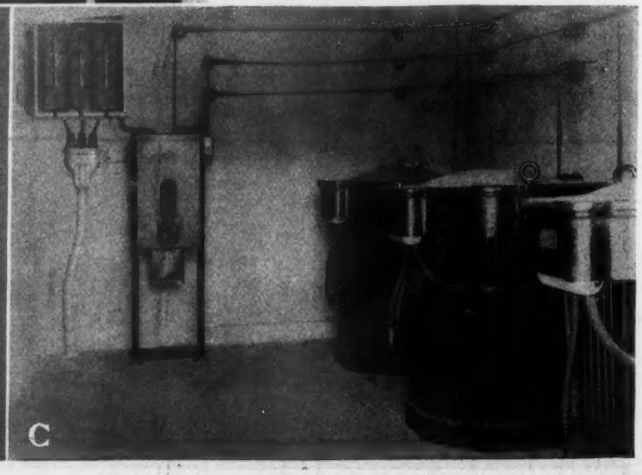
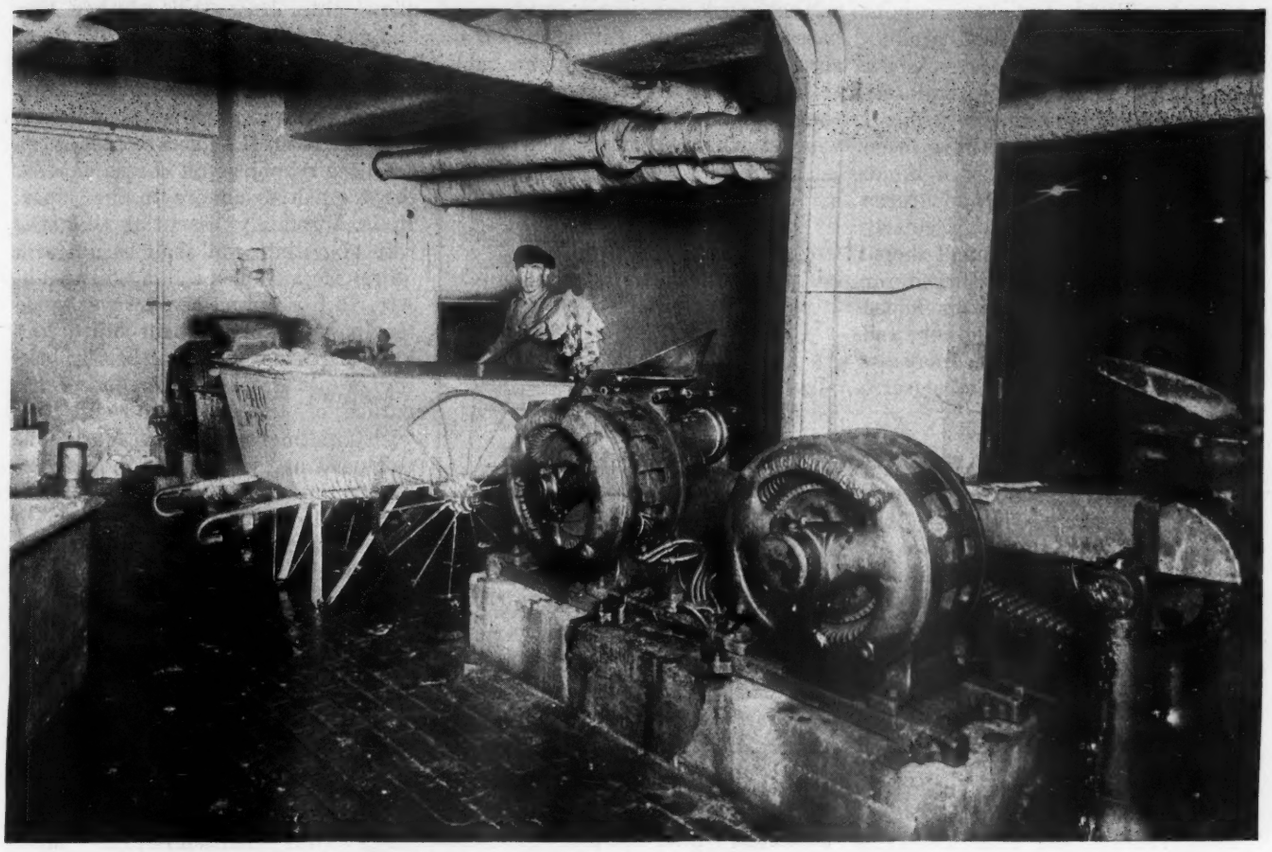


Fig. 4—Convenience and safety were considered first in this installation.

A. The secondary buses from the transformer bank feeding the low-tension lines through the secondary board in the main substation are carried on pipe framework 8 ft. above the floor, thus making it an easy matter to remove defective transformers. *B.* The low tension board is of the safety-first type. *C.* One end of the pumping plant substation, showing the bank of three 75-kva., 2,400-220-volt transformers. Costly bus work was avoided by running two 500,000 circ. mil cables from each transformer to a pull can back of the transformers and closing the delta there.



These motors operate meat grinders in a packing plant and are washed out, along with other apparatus, with boiling water at the nightly cleanup to remove grease accumulations. Under these conditions the average life of the insulation is about nine months.

Practical Details of

Insulating Varnish Tests That Are Easy to Make

In any Repair Shop and Indicate the Kind of Varnish Best Suited to Conditions Under Which Apparatus Must Operate

By H. L. HAZELTINE

Engineer of Insulation, The Sterling Varnish Co., Pittsburgh, Pa.

IN THE preceding articles the writer has taken up in a general way the characteristics of insulating varnishes and their solvents, the equipment for their application and some causes of troubles, with their remedies. The question that now most naturally arises is how to choose the varnish that is best suited to the conditions under which a particular piece of apparatus must operate. This is probably the most perplexing problem of all. There are so many of these insulating materials, which vary only slightly in composition and characteristics, that they tend to create confusion in the minds of the user. Yet each one is designed for a purpose.

Obviously the first step is to select the general type of varnish insulator that will be likely to give the best results. This may be done by making a careful study of the conditions to which the finished machine is to be exposed and the limitations of the shop equipment. The next step is to pick out the particular materials from this general class that will be productive of the best results.

As in other walks of life experience is the best teacher. It is, however, expensive to make production trials of many different varnishes, especially when some may be totally unsuited to the work and may be the cause of disastrous failures. Some other means of visualizing the characteristics of a varnish before purchasing in large quantities must be provided and for this reason tests on a small scale have been devised not so much to determine the actual suitability of a given product as to indicate those which are of sufficient interest to warrant a more extended trial.

Small shops are not usually equipped for making detailed scientific tests and hence they are inclined to leave the choice of a material to the personal opinion of the shop foreman or engineer rather than to a definite knowledge of the product itself. Tests of as elaborate or of as simple a nature as desired may be devised, but it is a general axiom that in most cases the action of any material under forced conditions is not the same as under normal conditions. Hence, when tests are used, as they should be, to indicate a product having characteristics that ap-

pear to be suitable and whose results are to be backed by actual production trials, the simple easy-to-make ones will be found to give satisfactory results.

Those outlined below have been designed with these ideas in mind. They require no special apparatus and, therefore, are particularly adapted to the needs of small shops. They are of necessity designed for general conditions, but it is hoped that they will suggest other and equally simple tests that may be made when special occasions arise.

Tests That Can Be Made In Any Repair Shop

Specific Gravity—Uniform specific gravity in a varnish is one of the most important requirements. It gives the user quick and definite information as to the uniformity of the product purchased and protects him against any change that might be contemplated in its manufacture. It also serves as a means of maintaining a varnish at a proper consistency.

An ordinary hydrometer graduated for liquids lighter than water (with readings less than 1.000) is all the apparatus required and should be a part of every shop equipment. When corrections for temperature variations are applied the readings are sufficiently accurate for any ordinary work.

The specific gravity of a varnish unfortunately varies not only with the percentage of base or useful material, but also with the nature of the solvent or base used and hence its measure is quite valueless when two different varnishes are to be compared. For example, a material having a solvent with a specific gravity of 0.720 and 50 per cent base would probably have a gravity of about 0.860, whereas one made up of the same solvent and 40 per cent base would have a gravity of only 0.832, but if the second material had a solvent with specific gravity equal to 0.790 its gravity would be 0.874. It will be seen, therefore, that contrary to rather general opinion the specific gravity is not a measure of the "body" of a varnish and should be used not as a means of comparison but as a means of maintaining the consistency of a particu'ar product.

Viscosity—The actual viscosity of a varnish is the measure of its rate of flow as compared to that of distilled water. Like specific gravity its value varies with the type of solvent used and the percentage of base; hence its determination has no significance in comparing the qualities of two different products. Furthermore, it does not indicate the way in which a material will flow from coils or other types of work. It is, therefore, not a quality of any particular interest and the small shop is hardly justified in purchasing the rather expensive viscosimeter required for measuring this quality.

IN THIS ARTICLE, which is the last of a series on insulating varnishes, Mr. Hazeltine describes some simple tests and gives the interpretation of results that make it possible to check up on varnishes that are being used for different insulating requirements and to select the type of varnish best suited to the conditions to which the apparatus is likely to be subjected.

The first article in this series appeared in the March issue and dealt with varnishes and their solvents. The second, in the April issue, took up methods of applying varnishes. The third, in the June issue, discussed the best ways to use varnish for protecting windings against moisture, oil and metallic dust. The fifth article, in the July issue, outlined common insulation troubles and explained the ways to overcome them.

When an article is dipped in varnish the varnish tends to run off thin at the top and to accumulate in a thicker coat at the bottom. The difference in thickness of film is known as the *slip* or *working viscosity*. It is evident that material having the *least slip* will drain more evenly from articles dipped in it and will deposit a more uniform coat than one having a *greater slip*. It will be seen, therefore, that unlike the actual viscosity, the *working viscosity* has a very interesting value to the user.

The *slip* in 10-in. or the difference in thickness of film taken at points 10 in. apart has been adopted as the unit of measure of *working viscosity*. It may easily be measured as follows:

Take a strip of a good quality of bond paper about 0.0028 in. thick, 4 in. wide by 18 in. long. With a lead pencil draw a line across the paper ½ in. from the bottom for a trimming line. Then 3 in. above this line draw another and mark it 12-in. line. Five inches above this draw another and mark it 7-in. line; five inches above this line draw another and mark it 2-in. line. Two inches above this draw still another line and call it dipping line. Dip a sheet to the dipping line in a deep vessel containing the varnish to be tested and withdraw at a slow, uniform rate of speed, taking care that there are no air bubbles on the surface of the varnish to adhere to the paper. It is absolutely essential that the rate of withdrawal shall be uniform otherwise an uneven film will result. After a little practice, however, good test papers can be made quite rapidly. Dry thoroughly either by baking or air drying according to the nature of the varnish used; then with a micrometer measure the thickness at the 2-in. line and at the 12-in. line. The difference is the *slip* in 10 in. A measurement of the thickness at the 7-in. line serves as a check on the result as the difference between this and the thickness at either the 2-in. or 12-in. line should be one-half the value obtained.

Dielectric Strength—These same test sheets may also be used for determining the disruptive strength of the varnish. Too much importance has been placed upon this test in the past at the expense of other more vital characteristics. Many small shops feel that because they do not have the expensive special testing sets required, they cannot judge the qualities of insulating varnishes and hence are inclined to abandon all tests on this account. It would be well to call the attention of such shops to the fact that many of the larger factories have abandoned this test altogether because of the difficulty of obtaining reliable results. Hence, it would be quite safe for the smaller shops to follow their example. The results obtained even when the test is most carefully made on highly specialized apparatus and on test specimens prepared with the utmost care do not justify the installation of the high-voltage transformer required, when such is lacking. A variation of as much as 100 per cent has been noted in the disruptive strength taken at different points on the same specimen. It would appear therefore that no varnish should be rejected for showing a low value alone. All insulating varnishes manufactured by reliable firms that understand the requirements have a dielectric strength greatly in excess of any that the user may put upon it. What difference does it make whether a material has a disruptive strength of 2,000 volts per mil or only 800 volts per mil when at least fourteen mils of insulation will be

used and the impressed voltage will not exceed 400 or 500 volts?

Flexibility or Heat Endurance—The same test sheets already described may be used in determining the degree of resistance to continued heat possessed by a given varnish. In preparing the test specimens care should be taken that the films are as near the same thickness as possible. Otherwise the heavier coat is liable to crack too soon due to the fact that the surface becomes hard and does not possess sufficient elasticity to prevent the soft material from bursting the outside skin.

After thorough drying the sheets are placed in the oven and baked at a uniform temperature of from 100 deg. C. to 105 deg. C. until the varnish cracks when the paper is creased. The time required before cracking occurs is a measure of the resistance to heat.

Oil and Water Resistance—A rough idea of the resistance of the film to the effects of oil may be obtained by rubbing the surface of one of these test sheets with a piece of waste that has been soaked in transformer or machine oil. Care must be taken that the pressure applied be as nearly as possible the same on each paper when comparisons are to be made. Care should also be taken that the varnishes are thoroughly dry and that they have all been baked at the same temperature.

Where more definite information is needed both oil and water resistance may be measured at the same time in this way: Take several pieces of perfectly clean copper ribbon about 2 in. wide by 5 in. long. Dip them in the varnish for about 4 in. of their length; then hang them in the drying oven and bake until thoroughly dry. Be sure that the varnish is dry. Then trim off about ½ in. of the bottom of the strip with a pair of scissors, as capillary attraction practically removes the varnish from the edges of a strip of copper. As the varnish and copper together have been cut at the bottom and the varnish does not extend up the whole length of the strip, it is apparent that we have two sheets of the varnish to be tested laid on one sheet of copper.

Next take a glass beaker or other suitable container deep enough to allow the immersion of the copper strips for about 3 in. of their length and fill the vessel 4 in. deep with water and ½ in. with any good quality of lubricating oil. Hang the test pieces in the liquid. This may be done by punching a hole through them and sticking a glass rod through. The rod may be laid across the top of the vessel so that it rests upon the edges. Care should be taken to see that the coppers do not come in contact with one another or within ½ in. of the bottom of the vessel. Then apply heat to the bottom of the container with a gas jet until it boils and continue the boiling until the varnish films are affected. This may be judged by removing the strips from time to time and testing with the finger nail.

It must be remembered in making oil resistance tests that transformer oil will have a greater effect than lubricating oil, hence it would be wise to use that oil to which the varnish will be subjected in practice.

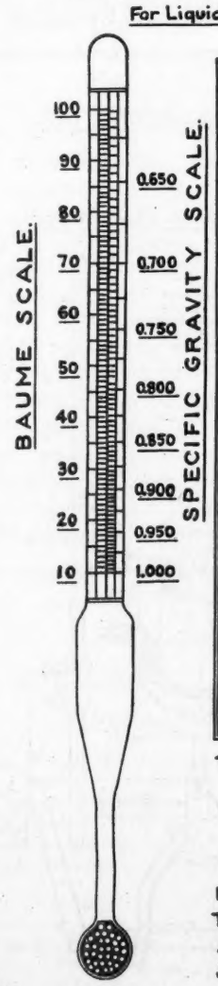
Acid and Alkali Resistance—Take a piece of close-grained wood about 4 in. wide and 5 in. or 6 in. long. Be sure that the surfaces are smooth. Treat it with varnish so that a good, continuous coat is formed. Place a drop of weak acid or alkali at several different points on the surface. Of course the water in these drops will evaporate and hence we will obtain the effect of acids and alkali at varying strengths. From time to time renew these drops until it is seen that the drop has broken through the surface of the varnish. A comparison of the times required will indicate the acid resistance of the different materials.

Penetration — Good penetrating qualities are of the utmost importance, as a varnish must be capable of passing through fibrous insulation and providing the protection needed

Hydrometer suitable for testing specific gravity of insulating varnishes, with Baume and specific gravity scales.

COMPARISON OF BAUME AND SPECIFIC GRAVITY SCALES.

For Liquids Lighter than Water at 15° C. (60° F.).



Baumé	Specific Gravity	Baumé	Specific Gravity	Baumé	Specific Gravity
80	0.667	56	0.753	32	0.864
79	0.670	55	0.757	31	0.870
78	0.673	54	0.761	30	0.875
77	0.676	53	0.765	29	0.881
76	0.680	52	0.769	28	0.886
75	0.683	51	0.774	27	0.892
74	0.686	50	0.778	26	0.897
73	0.690	49	0.782	25	0.903
72	0.693	48	0.787	24	0.909
71	0.697	47	0.791	23	0.915
70	0.700	46	0.796	22	0.921
69	0.704	45	0.800	21	0.927
68	0.707	44	0.805	20	0.933
67	0.711	43	0.809	19	0.940
66	0.714	42	0.814	18	0.946
65	0.718	41	0.819	17	0.952
64	0.722	40	0.824	16	0.959
63	0.725	39	0.828	15	0.966
62	0.729	38	0.833	14	0.972
61	0.733	37	0.838	13	0.979
60	0.737	36	0.843	12	0.986
59	0.741	35	0.849	11	0.993
58	0.745	34	0.854	10	1.000
57	0.749	33	0.859		

To convert degrees Baumé to Specific Gravity:

$$\text{Sp. Gr.} = \frac{140}{130 + {}^\circ B}$$

To convert Specific Gravity to degrees Baumé:

$${}^\circ B = \frac{140}{\text{Sp. Gr.}} - 130$$

Above scales are at the standard reference temperature 15° C. (60° F.), on which commercial ratings are based.

To find specific gravity at other temperatures;
Add 1° B. for every 5° C. (9° F.) below 15° C. (60° F.).
Subtract 1° B. for every 5° C. (9° F.) above 15° C. (60° F.).

in the interior of the windings. A rough determination may be made by taking a bar of metal or wood 1 in. square and 12 in. long. About this wrap many layers of the same cotton tape used in the shop, being careful that the lap is one-half the width of the tape on each test piece. In order to reduce the number of layers required, a layer of thin paper may be substituted for every fifth layer of tape, taking care that the paper passes once around the bar and that the edges come together without overlapping. Dip the bars in the varnishes to be tested allowing them to remain for exactly the same length of time; remove and dry thoroughly. Then with a sharp knife cut through the tape and paper and count the number of layers through which any traces of varnish can be found.

Shop Test—This experiment will show you the relative amount of care that must be taken in maintaining a given varnish; that is, whether the care to keep the base from going out of solution is excessive. The only apparatus required is a small container and a hydrometer. Fill the container with varnish of known specific gravity and allow it to stand with the top open so that the solvent will evaporate by action of the air and heat in the shop. Each morning measure the specific gravity and add sufficient solvent to bring the varnish back to the original consistency. A good varnish should stand this repeated thinning without livering or going out of solution for at least thirty days. In most shops the material stands in a tank for a considerably longer period. Of course, when the tank is covered, as it should be when not in use, not nearly so much thinning is required. Hence this test is considerably more severe than ordinary shop conditions would seem to require. Nevertheless it will give very definite information as to whether the care required of the material is so excessive as to make the cost of handling prohibitive.

Percent of Base or Useful Material—The most important test that can be made on a varnish is the determination of the percentage of base. It is not fair either to yourself or to those manufacturers of varnish who are supplying a minimum of solvent to purchase materials on a price per gallon basis. You are buying protection, not thinner whose only value is to provide flowing qualities and which passes off into the air once the varnish has been applied. You can usually purchase thinner nearly as cheaply as the varnish manufacturer and as you must thin anyway, you save yourself considerable in freight charges.

The importance of such a test is clearly shown by this episode. A company which had been buying a certain grade of varnish for a number of years decided to make a change because it would save them 6 cents a gallon on the purchase price. This material had been guaranteed as the equal electrically and in gravity to that which had been previously used. Nothing was said about it being equal physically. After six months' trial it was found that exactly twice as much of the new material had been used as was formerly the case with the old. An examination of the new product showed that it contained three quarts of solvent to every gallon of varnish, whereas the old contained only two quarts. The gravity was maintained equal by the use of a heavy solvent. Although the price per gallon of varnish was 6 cents less, the new material was more expensive to use and the ratio of the actual value was one to two because twice as much of the new material had to be used for a given amount of protection.

A rough estimate of this percentage of base may be made during the preparation of the test sheets described under *Viscosity*. If the varnish is weighed before the sheets are dipped and the dried film be weighed after the drying, with proper allowance for the weight of the paper, it may readily be seen that a very rough estimate may be made.

Again, if the specific gravity of the solvent used in the varnish is known the percentage of base may be determined by calculation from these same test sheets.

A more accurate determination may be made by the use of the ordinary distilling apparatus shown on page 156 of the March, 1924, issue of INDUSTRIAL ENGINEER for

Method of testing the resistance of varnish films to hot oil and water.

THE STERLING VARNISH COMPANY ENGINEERING DEPT.

PITTSBURGH, PENNA. U.S.A.

MATERIAL TEST SPECIFICATION Nº 2.

QUICK DETERMINATION OF THE RESISTANCE OF DRIED VARNISH FILMS TO HOT OIL AND WATER.

GENERAL.

This test is designed to determine quickly the resistance of a dried varnish film to boiling water and oil, and to give a method of comparison of results obtained. It is evident that a film which will withstand for a short time the strenuous trial given below is more calculated to meet ordinary service conditions than one which will be sooner effected by the test. It has been proved by long time-tests that such is really the case.

PRECAUTIONS.

Be sure that the varnish film is thoroughly dried right through. In order to have a definite and equal fashion of procedure, it is suggested that the test be made upon a film baked twice as long as the baking instructions given in directions for using the varnish in question.

APPARATUS.

A litre glass beaker 3½" in diameter and about 7½" high. Laboratory devices for holding as shown in sketch. A sand bath 6" in diameter filled with clean sand to a depth of ½". A standard bunsen burner.

SAMPLES.

Prepare samples of bright clean copper ribbon 5 mils thick, 2" wide and 5" long. Dip them in varnish to be tested for a distance of 3½". Allow to drain and then bake at a temperature and for a time twice as long as indicated on direction label for using varnish in general practice.

TEST.

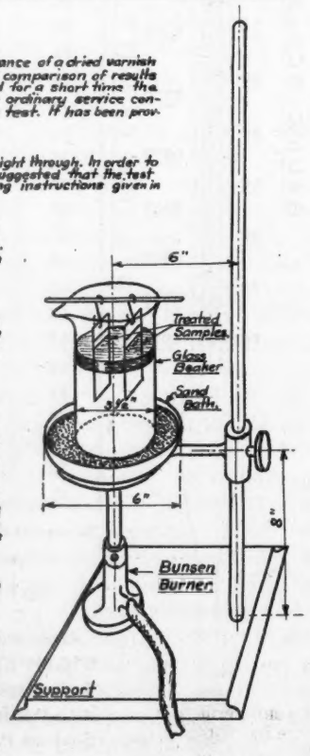
Assemble apparatus as shown in sketch. Fill beaker 4" deep with water and then pour carefully on top ½" of light machine oil. Hang treated samples in the liquids so that top of varnish film is ½" above surface of the oil and then bring to a hard boil with flame about 3" long. The water and oil should boil fiercely and times should be calculated from the moment the boiling commences. Take samples from oil every half hour and test with fingernail. Note time taken before varnish becomes soft, and until it is visibly effected and shows blistering and loosening of film. Consider the index number as the mean time in minutes of the two determinations made above.

REMARKS.

A good oil proof varnish will not be softened by the above test after 2 hours boiling and will show no visible effects after 4 hours boiling.

It is suggested that no varnish be considered as meeting a specification requiring oil proofness except when the index number found above is equal to or greater than 180. Those between 100 and 180 may be designated as fairly oil proof, and those below 100 should make no claims in this direction.

It is of course understood that the results of future work may change the above figures, and it is hoped that any observations tending to establish their accuracy or the reverse will be sent to this department, so that this specification may be changed and brought up to date.



determining the qualities of the thinner used. Considerable skill is, however, required in making this test and hence it is suited chiefly to those factories having an expert chemist.

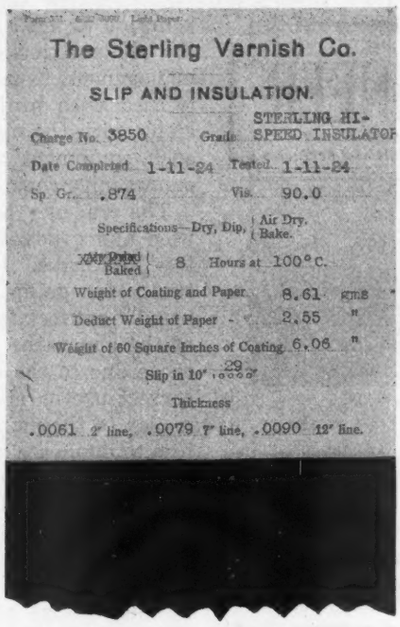
The tests outlined above are at the best exceedingly rough and the ideas as to the comparative merits of two different materials can only be estimated. Space will not permit a description of the more scientific tests requiring extensive laboratory equipment. These have been very ably described in the *Tentative Standards for Testing Insulating Varnishes* compiled by the American Society for Testing Materials. Those interested in the subject may obtain copies from the Secretary of that Society at Philadelphia, Pa.

Results of Tests Must Be Properly Interpreted

Tests, whether of the scientific kind or of the rough shop kind, have no value to the user of varnish unless the results are interpreted and brought to a common basis. It is quite true that some varnishes are worth more money than others due to their having stood the tests better, or to their having a higher percentage of base, or because the price per gallon is less. Stating this in mathematical terms, the value of a varnish varies directly with the test results, directly with the percentage of base and inversely as the price per gallon.

That is, we could write an equation in which the value of the varnish equals (test results × percentage base) ÷ (price per gallon).

The percentage of base and the price per gallon are both expressed in figures. If then the test results could be reduced to a number, we could express the value of a varnish by a number and the greater this number the greater the value of the material.


The Sterling Varnish Co.

SLIP AND INSULATION.

Charge No. 3850 Grade STERLING HI-SPEED INSULATOR

Date Completed 1-11-24 Tested 1-11-24

Sp. Gr. .874 Vis. 90.0

Specifications—Dry, Dip, { Air Dry. / Bake.

Air Dried / Baked { 8 Hours at 100°C.

Weight of Coating and Paper 8.61 gms

Deduct Weight of Paper - 2.55 "

Weight of 60 Square Inches of Coating 6.06 "

Slip in 10" 29 seconds

Thickness

.0061 2" line, .0079 7" line, .0090 12" line.

Sample of a test for slip or working viscosity of a varnish.

Details for making this test are given under the heading *Viscosity* on page 382. It helps to pick out a varnish that will drain evenly and provide a uniform coat when articles are dipped in it.

It is quite possible before starting tests to determine a set of ideal values which represent approximately our idea of the relative importance of the qualities one to another and to the whole, or 100.

Suppose that we were testing varnish for the treatment of apparatus which will be subjected to considerable heat and to strong acid fumes. The qualities that most interest us are: flexibility or life at 105 deg. C.; elasticity or resistance to the expansion and contraction of the metal used in the machine under service conditions; acid resistance and comparative dielectric strength.

Dielectric strength being of the least importance could be given a numerical value of say 10; life, acid resistance and elasticity being of equal importance could be given an arbitrary value of 30 each. We could then tabulate our values as shown in the table below.

The values for the samples are determined in this way: Suppose the values for the dielectric strength in volts per mil for each of the four samples are: No. 1—1,600; No. 2—960; No. 3—1,280; No. 4—640. If 1,600 volts are taken as the ideal value, or 10, 960 is 3/5 of 1,600 or 6, and so on.

The relative value is determined by multiplying the percentage of base by the test totals and dividing by the cost per gallon in cents. It will be seen that sample No. 1 is the relatively best purchase because its relative value is the highest.

Without this interpretation, the choice of the engineers would probably be No. 4, although the small percentage of base and the high cost per gallon do not warrant its adoption. Sample No. 3, on the other hand, would be the purchasing agent's choice, as its price is the lowest. Sample No. 1 is the better purchase on the basis of percentage of base alone in the ratio of 50 to 40. That is, to be an equal purchase on a price basis No. 3 should sell for 4/5 as much as No. 1, or 88 cents per gallon.

By this method it will be seen that the personal element has been eliminated from every feature having to do with the selection of varnishes, except the detail tests. The design of these tests should be such as to eliminate this feature as much as possible also.

It will be noted that in the list of qualities under *Tests That Are Easy to Make*, the elasticity has been mentioned, although no test for it has been described. Elasticity may be defined as that quality of a varnish which enables it to resist the strains put upon it by the expansion and contraction of the metal, during operation, in the machines to which it is applied. It is probably dependent upon the amount of drying oil contained in a particular material, the nature of the drying oil and the way in which this drying oil has been treated in manufacture. The quality may best be determined by a comparison of the way in which the machine (*Continued on page 402*)

Comparative Data From Tests on Four Samples of Insulating Varnish

Property	Ideal Values	Sample No. 1	Sample No. 2	Sample No. 3	Sample No. 4
Dielectric strength	10	10	6	8	4
Elasticity	30	25	22	10	24
Life at 105 deg. C	30	20	15	17	26
Acid resistance	30	25	20	16	28
Totals	100	80	63	51	82
Percentage of base		50	45	40	42
Price in cents per gal		110	108	96	130
Relative value		36	26	23	26

INDUSTRIAL ENGINEER

Devoted to the Maintenance and Operation of Electrical and Associated Mechanical Systems in Mills and Factories

DANIEL H. BRAYMER
Editorial Director

Assisted by

G. A. VAN BRUNT F. E GOODING A. J. WHITCOMB

Chicago, August, 1924

A Suggestion About Plant Housekeeping

PLANT MEN may take a tip from the good housewife who, during her annual spring and fall housecleaning, turns everything over, moves it around and gives it a thorough going over even though she sweeps and dusts several times a week throughout the year.

Some plants approach this weekly clean-up by shutting down machines from a quarter- to a half-hour earlier on Saturday and have each man wipe off his machine and tidy up the space he occupies around it. Even with this, however, an annual clean-up is worth while as many things accumulate during the year which really belong elsewhere. With some industries the summer is a slack time which offers an excellent opportunity to make a real housecleaning job of the clean-up. Then everything movable can be shifted and cleaned under and around, accumulations disposed of and paint brush applied here and there where necessary. Lamps, lampshades, windows and skylights, generally need more frequent attention but if they haven't received it here is a good opportunity to give them a thorough cleaning.

The Hows and Whys of Equipment Failures

IN A conversation last month with the superintendent of a large paper mill he referred to the difficulties of making repairs and changes on equipment when little thought has been paid to standardization and various types and makes of apparatus have been installed, with price largely governing the selection. In such a case a piece of apparatus is installed to try it out; then another that seems to have some better points but is no more expensive, until a switchboard or control section has a variety of devices for which repair parts must be carried or considerable expensive apparatus junked to start in on any plan of standardization that will be at all comprehensive.

Right here is a real problem. When someone before you has installed the miscellaneous apparatus and it's your job to make it operate, the suggestion to tear out the old and install new equipment is one which the management usually frowns upon and considers a little tainted with prejudice. So the usual plan is to get along with the old as best you can and replace it with such equipment as can be standardized upon as the opportunity comes up.

The tendency is to hold on to the best that has been used and gradually add the most modern of the same type and make. Here, the operating man has an opportunity for doing a manufacturer a good turn that is usually appreciated. He can make a report on failures of the apparatus, indicating their causes and point out those due to the equipment itself and those due to incorrect use or abuse. Such reports are usually worth money to the manufacturer because it is impossible for him to duplicate all the various pranks of actual service on his test floor and it is mainly through the experiences of operators and troubles that develop from service that the best form of design is evolved.

As this particular superintendent pointed out, it is a better plan for an operator to help perfect equipment by suggestions offered to the manufacturers, than to shop around to find something that is just right when he gets it but that adds type and different design complications to the equipment layout unless the entire plant can be rebuilt and new equipment installed. Even then the man who keeps records of the hows and whys of failures is the one who usually knows how to avoid them in the new layout.

Economy In One Direction May Be Waste In Another

AN OFFICIAL of a company that specializes in the repair of motors and certain industrial material-handling equipment recently said: "If plant owners would see to it that their equipment is properly taken care of, we would not have much to do. Ninety per cent of the failures in the equipment we handle are due simply to lack of proper attention."

The fact that maintenance is much cheaper in the long run than neglect and consequent repairs, has still to be learned by some factory managements and owners. It is an expensive lesson, but when it has once been learned it is never forgotten. The production losses entailed by the failure of an important piece of equipment and the cost of a rewind job, say, will ordinarily buy a good deal of maintenance.

A certain amount of repair work is necessary and inevitable. Bearings will wear out in time; equipment will be abused or receive injury in one way or another; and parts will occasionally break under the stresses imposed by unusual service conditions. Nevertheless, the amount of repair work caused by these mishaps is, in many plants, very small when compared to the amount of repairs that are caused by improper application, operation and care of the equipment.

The issue is simple: There is no escape from the fact that it costs money to operate and use equipment. The only question is whether this money shall be spent for properly-directed maintenance, or whether a greater sum shall be spent for repairs which are occasioned by the lack of attention. In the first instance the amount to be spent can be closely estimated and controlled; in the other it is a very uncertain quantity, and "the sky is the limit," as the saying goes.

Make a Graphic Picture of Your Plant Load

A POWER SURVEY of the plant load, made at regular intervals, is one of the best forms of insurance against power distribution failures that the plant engineer could ask for. An underground-cable failure that recently occurred in the coke plant of a large steel mill, is a case in point. Increased power demand and the addition of a few motors increased the load on this cable to the point where a disastrous burnout occurred half-way between two manholes. Since coke-making is, of necessity, a continuous process, the production loss and scrapped product caused by the loss of power from this cable can be readily imagined. An investigation undertaken *after* the failure had been repaired showed that not only was the cable overloaded but it was located in the vicinity of some steam pipes which, through the heat radiating from them, reduced the carrying capacity of the cable.

A power survey, similar to the one which Mr. Stafford describes in his article beginning on page 360, would have gone far towards eliminating a failure such as the one mentioned. A power survey of the load of the entire plant gives a mass of data that is hard to visualize; if the survey is made at yearly intervals, it is difficult to compare the results of each survey. Mr. Stafford in his article gives a line diagram which shows the location, size and connected load of each circuit, and also gives a chart which shows the comparative value of the departmental loads together with the power factor and the power and wattless components of each department or circuit. By means of these two diagrams the factors of the distribution system can be readily visualized and compared.

A power survey repeated at regular intervals and charted and analyzed as described will lead to conclusions that will save many a midnight cable repair job.

If You Are Sure It Can't Be Done You'll Never Do It

IT is usually easier to say that a thing can not be done, than to go ahead and do it. Perhaps this is one explanation of the interesting fact that many of the outstanding developments and inventions have been made by men whose training and experience were confined to other fields than the one in which they attained prominence.

For example, Pasteur, who discovered the antitoxin used in the treatment of hydrophobia, was not a physician. Bell, the inventor of the telephone, was a teacher of the deaf—not an electrician. Morse, the inventor of the telegraph, was a portrait painter. Ingersoll, who made the dollar watch famous, was a farmer, not a jeweler or watchmaker. Columbus, the discoverer of America was a comber of wool, not a sailor. The Wright brothers, who conquered the air with their flying machines, were originally bicycle repair men, not scientists.

This list might be extended to considerable length, but it is long enough to illustrate the point. Wide or increasing knowledge of a certain field often seems to bring with it merely a wide variety of reasons why certain things can not be done. In fact, the discoverer of insulin, by far the most valuable curative agent for diabetes, has been quoted as saying, in effect, that when he started work on this problem he did not take the trouble to become thoroughly familiar with all of the theories which have been put forth, or the work which had been done previously; if he had done so he would probably not have made his brilliant discovery. In other words he would have known too many reasons why diabetes could not be cured.

There are many other instances where scientists and inventors have united in declaring that certain things could not be done; and then somebody who had not heard of this verdict, went ahead and did them, because he did not know that they could not be done.

Almost anyone can give a dozen good reasons why certain desired results can not be obtained—but the world liberally rewards the man who can give even one reason why they can be obtained, and then proves it.

Don't Always Blame the Brushes

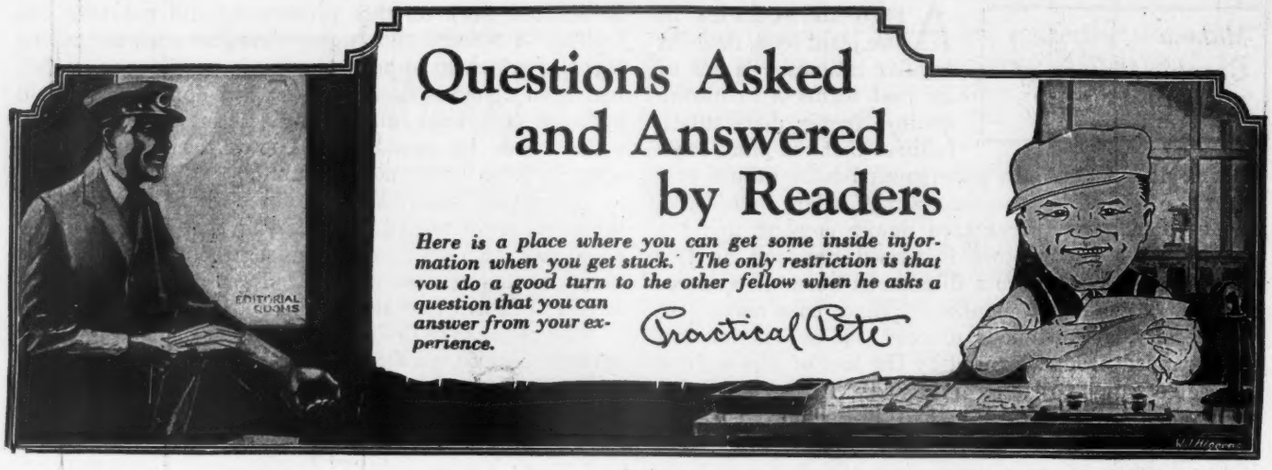
POOR commutation can be caused by a great variety of things. Too often in a case of commutation trouble, the superintendent is unduly influenced by the operator's report that the brushes are at fault, with the result that a competitive brush manufacturer is called in to prescribe new brushes.

This calls to mind the case of a generator furnishing the direct-current supply to a 5,000-hp. reversing motor driving the rolls of a billet mill in a steel plant. The duty required of this machine is exceptionally severe; hence any slight trouble experienced with the commutation of the machine rapidly becomes worse until destructive sparking takes place. This machine was operated for several years without more than ordinary trouble. Finally, however, commutation trouble set in. It soon got to the point where the commutator would flash over and a shut-down and repair work would be required. The electrical superintendent decided that the brush manufacturer was not making brushes as good as formerly and bought a new grade of brushes from a competitive manufacturer. The new brushes, however, did not function better than the original ones. Five more grades from several other manufacturers were tried with indifferent results.

Things were going from bad to worse and as a last resort a brush engineer from the manufacturer of the original brushes was called in. He diagnosed the case as commutator trouble and not brush trouble. He directly supervised the job of undercutting the mica and grinding the commutator and the job was done in a much more painstaking manner than was customary at that plant. The brushes were seated accurately. The spacing of the brush arms was found to be slightly off; so this was corrected. Needless to say no more brush or commutator trouble has been experienced with that machine.

Another case is recalled of a commutator on a motor-generator set in which four grades of brushes were tried before it was discovered that the commutator was not thoroughly seasoned and hence after being carefully ground, the bars would shift slightly—just enough to cause poor commutation. Obviously the trouble could be permanently corrected by seasoning and regrinding the commutator.

Instances like these show the time and money-saving value of suspecting other things besides the brushes when troubles show up at the commutator.



Questions Asked and Answered by Readers

Here is a place where you can get some inside information when you get stuck. The only restriction is that you do a good turn to the other fellow when he asks a question that you can answer from your experience.

Practical Pete

Who Can Answer These?

How Does Change in Speed of Motor Affect Horsepower?—I shall appreciate it if some reader of INDUSTRIAL ENGINEER can answer the following question: We have a 3-hp., 3,600-r.p.m. motor which we are changing to operate at 1,800 r.p.m. I should like to know what the approximate horsepower of the motor will be after this change, if we use the same number of turns of the same size wire in the stator.
Enid, Okla. C. E. S.

* * * *

How Should This Machine Be Placed?—It is common practice to place a pulley at right angles to a lineshaft which, of course, means that the belt has no twist in it. However, we have a 125-ton press and would like to place it in such a position that the pulley on this press will be 45 deg. from the lineshaft. I should like to know, (1) if this is an unusual way of running a belt, and (2) how should the machine be placed with the pulley in this position, so that the belt will not be continually slipping off.
Philadelphia, Pa. A. T. S.

* * * *

Trouble with Traveling Cranes—I am having trouble with two traveling cranes which run on the same track and are used for loading and unloading stone in a mill. One crane is rated at 20 tons and the other at 30 tons. Each crane has two slip-ring motors of about 20-hp. rating, which operate at 220 volts, sixty cycles and are controlled by General Electric starters. When both cranes are in operation the hookers on the ground get a shock every time they touch the chains which are used to carry the load. When either one of the cranes is idle, the men do not get a shock. I have tested out all circuits with a magneto and was not able to find any indications of trouble. I shall appreciate it very much if any of the readers of INDUSTRIAL ENGINEER can tell me how to find this trouble.
Bloomington, Ind. H. M.

* * * *

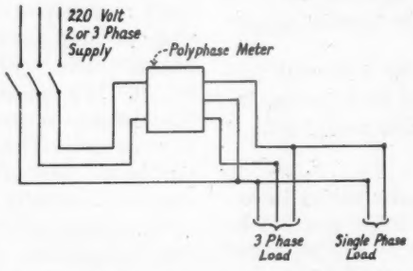
Why Do These Commutators Turn Black?—I am experiencing a great deal of trouble from blackening of the commutators on two G. E. belt-driven, type ML, compound-wound, 125-volt, 950-r.p.m., 13 kw., d.c. generators which are used as exciters. After smoothing with sand paper, it is only a matter of a few hours until the commutators are in the same condition again. I have tried turning the commutators in a lathe and undercutting the mica, polishing, sanding, using Ideal commutator stone and tightening the commutator. Also, I have used four different grades of brushes and am now using Speer E-25 brushes. There is no sparking at all under varying loads. The setting of the brush holders was changed from leading to trailing and I found that they worked best leading. I have tried the brushes at different angles and found that the best results were obtained when they were set at about 80 deg.

We wipe off the commutators once each day with a dry piece of canvas. I have checked the brushes for the neutral position. The tension on the brushes is 1½ lb. per sq. in. The temperature seems normal except when the commutators get very black as they will do if they go about a week without sanding. These exciters are only two years old and have been in actual service about one year each. I have had this trouble from the start.

I shall appreciate it very much if some reader of INDUSTRIAL ENGINEER can tell me what the trouble is and how I may cure it.
Woodward, Okla. H. J. A.

* * * *

Single-Phase Load on Polyphase Meter—Will some reader of INDUSTRIAL ENGINEER please tell me what will be the difference, if any, in the real power consumption as compared with the meter reading when a single-phase load and a polyphase load are taken from one polyphase meter, as shown in the diagram. The polyphase load seems to



be registered correctly, but will the meter register too much when single-phase power is used? If so, would the same result be obtained on both two-phase and three-phase circuits?
Northampton, Mass. L. G. D.

* * * *

Trouble with Collector Rings of Turbo-Generator—We have a 2,300-volt, 60-cycle, 750-kva. three-phase, 3,600-r.p.m. generator driven by a steam turbine. We are experiencing trouble with one of the collector rings carrying direct current for excitation. This ring develops flat spots and what appear to be burned places all around it. The other ring has a fine polish without these spots and flat places. We changed the leads from one ring to the other and the spotted ring was trued up and polished. Then the ring that was first in good shape developed spots and flat places in the first two days after the leads were changed. The brush tension and brushes have been checked and we do not believe that the trouble is due to the brushes, as we are using the manufacturer's brushes. The proper exciting current is maintained and the rings seem to be true, although two years ago one of the rings became very hot and had to be reground as it was a little out of true. These rings are subject to much coal dust and oil vapor, but as the different rings spot up and have flat places all around them at about the same distance apart with the changing of the leads, I do not believe it is due to dirt. I should like very much to hear from others who have overcome trouble of this sort.
Zeigler, Ill. E. P.

Answers Received To Questions Asked

In the July issue of INDUSTRIAL ENGINEER S. S. gives a sketch of an iron bracket or fixture which he contemplates using to support two sets of feeders, and asks if there is likely to be any inductive or other troublesome effect. I can see no reason for not using this fixture, as feeders supported on the cross member will be in the same situation as if they were run through a short piece of large diameter conduit, while supporting the other feeders on the outside of the bracket will be, in effect, the same as supporting them on a beam or girder, as is commonly done behind switchboards and in other station work.
Denver, Colo. JOHN E. HOLTMAN.

* * * *

Alarm System to Indicate Hot Bearing—We have had considerable difficulty on some heavy pressure rolls due to bearings getting too hot before they were discovered. I have heard that it is possible to use an alarm system of some sort for indicating when bearings get beyond a certain temperature. Can any readers tell me how a device of this sort may be made and installed?
Gary, Ind. L. M. C.

In answer to the question asked by L. M. C. in the June issue of INDUSTRIAL ENGINEER, I would refer him to the advertisement inserted by The Automatic Reclosing Circuit Breaker Company, Columbus, Ohio, on page 86 of the advertising section of that issue. This describes their type TR thermal relay which I am sure can be successfully applied to L. M. C.'s problem. I would suggest that he correspond with the above company, stating his problem, and believe that they would be glad to work out a suitable alarm system which would operate when the bearings reach a certain temperature. I would like to say here that I find INDUSTRIAL ENGINEER to be a reliable source of information on the problems of both operating and repair men, and I would not miss an issue for anything.
Birmingham, Ala. GRADY H. EMERSON.

* * * *

In the June issue L. M. C. asks for an alarm system for hot bearings. This might be accomplished by installing a battery and bell between the lower half of the bearing and the shaft. Connection to the bearing should be made by soldering, and to the shaft with a car-

bon or copper brush. The upper half, or cap, of the bearing, should be separated from the base by insulating shims, and the cap bolts insulated also. Where a perfect oil film exists between the shaft and the cap, insulation would not be necessary.

The operation would be as follows: With the shaft at rest there is, of course, metal-to-metal contact between shaft and bearing. In this condition the bell would ring unless the circuit were kept open by means of a switch. With the shaft running, an insulating film of oil is formed between shaft and bearing and the current would be interrupted. Should the oil film be broken and lubrication destroyed, the circuit would be closed and the bell would ring.

Should L. M. C. try this scheme he should, as his share to this contribution, report the results to Practical Pete.

Kansas City, Mo. C. O. SANDSTROM.

* * * *

Answering L. M. C.'s question in the June issue, I would suggest that a thermo-couple be placed in the bearing shell, or attached to it in such a way that it will be directly affected by the heat. The leads should be connected to a pyrometer, an instrument which registers the temperature in degrees. On the scale of the instrument place a small contact at the point where it is desired to have the alarm sound. The needle or pointer will be the other contact. To these contacts connect a battery circuit with a small relay in series. The relay must have a movable contact and should be connected to a 110-volt lighting circuit, with a bell, horn, lamp or other signaling device in series. A small electro-magnet with an armature bearing a contact may be used in place of the relay.

As the bearing heats up during operation the indicator of the pyrometer will move across the scale so that the temperature can be read in degrees at any time. When the maximum allowable temperature is reached the contacts on the scale will close, which will cause the relay to be energized and close the alarm circuit. The leads from the thermo-couple to the instrument should be as short as possible in order to keep the resistance down.

Seattle, Wash. PAUL E. THOMAS.

* * * *

Selection and Application of Carbon Brushes—Can any of the readers of INDUSTRIAL ENGINEER give me any information on how to choose and properly apply the various grades of carbon brushes? I should like to know how a practical man can by inspection and simple tests choose a suitable brush for a job or determine what application a certain brush is most suitable for. I have seen references to the electrolytic action between brass collector rings and carbon brushes and should like to know the cause of this action and if there are any means of overcoming it.

W. A. P.

Smooth Rock Falls, Ont., Can.

Referring to the inquiry by W. A. P. in the June issue I think that the best thing he can do is to get information from the brush manufacturers.

In general, however, a hard, dry carbon brush is best for high voltages, say over 230 volts, and for machines with high voltage between segments, and not many segments in the commutator. They are good also where there is poor commutation, due to excessive armature reaction and consequent shifting of the commutating plane or neutral point.

Medium carbon brushes, or carbon brushes containing a lubricant, or a mixture of carbon with graphite, cannot be used on the higher voltages because the soft particles rub off and ignite from the current caused by the voltage between segments. They can be used to advantage on some machines which have low speed and large commutators, which will have a low voltage between segments.

In regard to the electrolytic action between rings and brushes, I have had some experience with this but found that it occurred during the peak of the wave and only when one set of brushes was used. By putting on another set in parallel, but 90 deg. from the first set, I found that the trouble vanished. The second set of brushes was easily installed by putting another brush holder on the same stud but pointing in the opposite direction, which separated the brushes the distance of twice the length of the holder.

Boston, Mass. EDWARD A. GIBBS.

* * * *

In reply to W. A. P.'s inquiry in the June issue regarding the selection of carbon brushes, the first step is to learn the properties and uses of the four classes of brushes as follows: carbon-graphite, electro-graphitic, natural graphite, and metal-graphite. The carbon-graphite class is usually the least expensive. The various grades of brushes in this class are hard and strong with some abrasive action, and are adapted for flush mica generators or motors where commutation is not severe, but where the mechanical service is strenuous. A typical application is the series-wound crane motor with its frequent stopping and reversing. The electro-graphitic class has more favorable electrical properties, but has not the rugged physical characteristics of the first class. Most of the grades in this class are entirely non-abrasive and accordingly give better results on slotted commutators. These grades are used on machines where commutation is severe and where the current per square inch of brush cross section is high. Typical applications are the d.c. side of rotaries and heavy-duty, compound-wound motors with undercut mica. Natural graphite brushes are used for still higher speeds and current densities where very soft brushes are needed to overcome chattering, as on turbo-generator field rings. Metal-graphite brushes have very low contact resistance and very high carrying capacity. On account of the former characteristic they are used on low-voltage machines such as electric trucks to minimize the voltage loss; due to their ability to carry as much as 150 amp. per sq. in. they are invaluable for applications such as rotary collector rings.

After determining which class of brush should be applied to a machine the proper grade can be selected by noting the following machine conditions: current density in the brushes (the load current divided by half the number of brushes × the width × the thickness); peripheral speed of the commutator (.262 × diameter × r.p.m.); the extent that commutation is a problem (interpole machines have less severe commutation than non-interpole); the condition of the commutator, whether undercut or flush mica.

Select a grade with a rated carrying capacity at least equal to the current density in the brushes; short overload periods will be taken care of. The recommended maximum surface speed of this grade should not be less than the peripheral speed of the commutator. If the machine is non-interpole or has severe commutating characteristics the grade should have a fairly high contact drop to suppress the reactance voltage; otherwise a lower contact drop grade should be used to reduce the voltage loss. Undercut mica machines should use a grade with no abrasive action; flush mica machines should use a grade with enough abrasive action to keep the mica flush with the bars.

The only accurate test to give a brush is an actual service test. It is difficult to choose the proper brush by inspection, since the average individual cannot readily distinguish any marked difference in the various grades. For this reason it is much easier to choose a brush to fit a particular machine than it is to choose a machine to fit a certain brush.

There is an electrolytic action between brass collector rings and carbon brushes due to the fact that the current passing between them causes an unstable condition. The negative brushes will show specks of copper which have been deposited from the ring and the positive ring will show a carbon deposit from the brushes. Heat increases the electrolytic action and, accordingly, a brush with higher carrying capacity or lower friction may remedy the situation to some degree.

Corliss Carbon Co. L. J. KERLIN.
Bradford, Pa.

* * * *

In answer to W. A. P.'s question in the June issue, I do not know of any simple tests to determine the suitability of carbon brushes. The selection of brushes depends on the character of the service; that is, whether they are to be used on slip rings or commutators; the class of motor, such as mill-type, traction or stationary; and so on. Also, it makes a difference whether the motor, if d.c., has a milled or unmilled commutator. The current-carrying capacity must likewise be considered.

The National Carbon Co. recommends from 1¾ to 2¼ lb. per sq. in. brush pressure for slotted commutators on stationary motors and generators operating under average conditions, 2 to 3 lb. per sq. in. for mill and elevator motors, 3 to 5 lb. per sq. in. for crane motors and 4 to 7 lb. per sq. in. for traction motors. For use on undercut commutators they recommend the following grades: for high-speed rotaries and turbo-generators, peripheral speed above 5,000 ft. per min., Nos. 257 and 634; for stationary motors, generators

and rotaries with peripheral speed below 5,000 ft. per min., No. 255; for mill and elevator motors, No. 401; for crane motors, No. 401 or No. 407; for railway or traction motors, Nos. 203, 222, 255, 401, 402, 407.

For motors with unmilled commutators an abrasive brush should be used in order to keep the mica worn down flush with the commutator bars. In general, carbon and graphite brushes are used for average applications; pure graphite brushes are used to secure high current capacity with lubricating qualities, and carbon-metallic brushes are used for slip rings.

I believe W. A. P. could secure information on the electrolytic action of carbon brushes and brass slip rings from the manufacturers of carbon brushes, who have, I presume, means of determining such action. The testing of brushes calls for much experimenting and I am sure that the reliable brush manufacturers carry on these experiments.

Birmingham, Ala. GRADY H. EMERSON.

* * * *

Winding Data for Transformer of Rectifier—Can some reader of INDUSTRIAL ENGINEER tell me how many turns there are on the transformer of a 5-amp. Tungar rectifier? I dismantled my rectifier some time ago and have lost the winding data.

Valparaiso, Ind. A. T. M.

In answer to A. T. M.'s question in a recent issue, I am giving the winding data for the transformer of a 5-amp. tungar rectifier which can be used on a 110-volt alternating current circuit for charging a storage battery at six or twelve volts. The winding is the same for 25 or 60 cycles, but the core is different.

The diagram shows the number of turns and the method of connection. Sections (A), (B), (C) and (D) are wound with No. 16 wire; (E) and (F) are wound with No. 10 wire and (G) is wound with No. 6 wire, or rectangular wire of the same area.

It is best to wind sections (E) and (F) first, and wind (G) on top of them. The sections should be wound carefully in layers on account of the small space between the core legs.

Duluth, Minn. FRED LARSEN.

* * * *

What Causes This Motor to Spark at the Brushes?—I have a 35-hp., four-pole, shunt-wound motor that drives a fan. The armature has seventy coils, lap-wound. Under load this machine draws 280 amp. at 115 volts and has always sparked viciously. The brushes are of the Bayliss type and I find the neutral point with a voltmeter as closely as one can. When I stone the commutator down the motor runs satisfactorily for a day or so and then sparking begins and the commutator develops low bars and seems to flatten or sink.

I am wondering if this armature was designed for a four-pole machine, as it has seventy bars and coils. This number is not divisible by four without a remainder and thus throws the neutral point in the center of a bar. I shall be very grateful if some reader can explain what causes the sparking and tell me how I can overcome it.

New York, N. Y. C. E. K.

In answer to C. E. K. in the March issue, the commutator of this 35-hp. motor likely has loose bars, which lower just enough to catch the toe of each brush. As the brushes are of the Bayliss type they are set with the toe against the direction of rotation. The bolts at the end of the commutator should be drawn up tightly and the bars turned down in a lathe. If the motor is not overloaded and each stud carries its full quota of brushes with sufficient contact area, all set at the proper angle, the sparking will not appear. The Bayliss Co. will gladly recommend the proper size and number of reaction brushes for a 35-hp. motor, if our correspondent will give them all the data needed, as to motor and load.

New Britain, Conn. H. S. RICH.

* * * *

In reply to C. E. K.'s question in the March issue of INDUSTRIAL ENGINEER, if the motor pulls a current of 280 amp. at 115 volts, it is evidently overloaded, or else has an efficiency of only 81 per cent. A motor of that size should have an efficiency of somewhere near 95 per cent and would then draw 239 amp. at 115 volts.

It would be well to take a reading of the voltage at the motor terminals to ascertain for sure whether there is a full 115-volt supply. A low voltage would cause the motor to take an increase in current. From the description of the trouble given, the indications are that there is either a high-resistance connection or an open circuit, usually in the armature circuit.

If only certain bars seem to flatten or sink, the trouble is usually a high-resistance connection where the riser connects to the commutator bar or where the armature conductor connects to the riser or commutator bar. Or the coil connecting to the sunken commutator bar may be found to be open.

However, if all the bars seem to burn the brushes may not be making good contact with the commutator or may not be of sufficient carrying capacity, or the field poles may not be of equal strength.

Muncie, Ind. GEORGE CROPPER.

* * * *

Lining Up Gears and Pinions—I would like to know some of the methods that readers of INDUSTRIAL ENGINEER use in lining up spur and bevel gears. How can I tell whether the gears and pinions are meshing too deeply or not deeply enough? I know how it should be done theoretically, but I would also like to know how it is done practically, out on the job.

Youngstown, Ohio. H. H.

Answering the question by H. H. in the May issue of INDUSTRIAL ENGINEER, first line up the shafts in their approximate position horizontally, with a spirit level placed on some part of the shaft. The level may be placed near the ends, with the pinion and gear removed. To line them both at the same height place the level across both, if the shafts are of the same diameter.

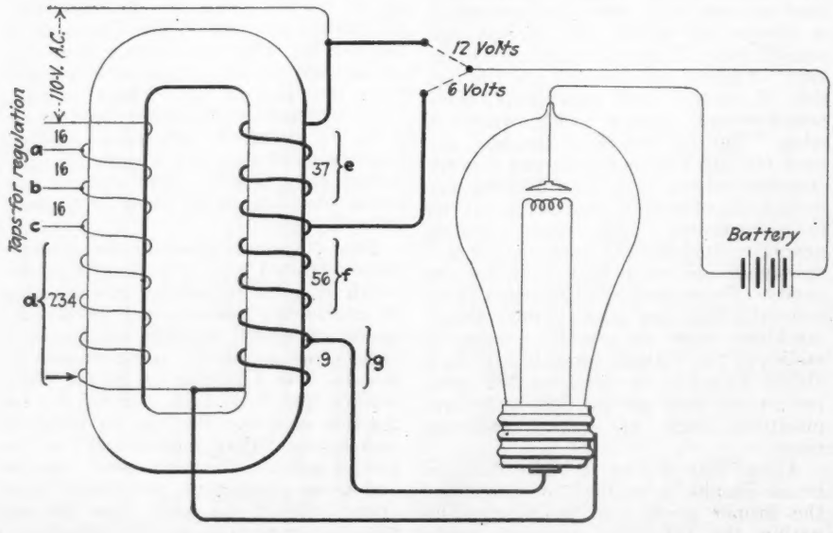
If they are not of the same diameter it will be necessary to shim under the level on the smaller shaft an amount equal to one-half of the difference in the diameter of the two shafts. If the level is not long enough to reach across the shafts a straight-edge may be placed under the level. The shims used should be of uniform thickness and perfectly flat so that a sidewise movement of the machines will not alter the horizontal line-up. Put the gears on and if necessary to move the machines mark the shims so that they will go back in the same place.

Set the gears in mesh as closely as possible with the eye and bolt the machines down firmly, using two bolts or lag screws 1-16 in. or ⅛ in. smaller than the holes in the base. Then take two pieces of string or wire solder, one on each end of the teeth, and run them in between the gears at a right angle to the teeth, turning the machine by hand or with a bar. The thickness of the pressed portion of the two pieces of solder may now be measured by a micrometer or calipers. If they are the same thickness the gears may be considered to be lined up accurately enough for any ordinary conditions. If both pieces of solder are not pressed alike one machine should be moved slightly and the test repeated until they come right.

The thickness of the solder is also an indication of the correct spacing or clearance. The formula for clearance is 0.157 ÷ diametral pitch. Feelers may be used in place of the solder to

Winding data for 5-amp. rectifier.

The numbers opposite the sections of the winding give the number of turns in each section.



check the clearance if the gears are large enough to allow this to be done.

It is well to recheck each shaft for horizontal line-up and if this is all right the remaining bolts may be put in, full size, and the machines doweled, if practicable, to insure future alignment.

If the gears are very small the solder may be flattened out before running it between the teeth. If large gears are being tested two or more pieces of solder may be twisted tightly together like a rope. If care is taken to line the shafts perfectly horizontal in the first place the method described above will be found to be very accurate, requiring a minimum of tools, mistakes and figuring. CHESTER A. WILLIAMS.

Electrical Department,
Providence Gas Co.
Providence, R. I.

* * * *

Replying to H. H.'s question in the May issue of INDUSTRIAL ENGINEER, most of the gears made today are cut involute, which gives a true rolling motion of one tooth upon another, regardless of the depth of engaging. However, where a gear train is subject to reversing or when it always revolves in the same direction but the driven wheel shaft is braked in stopping, backlash is objectionable and causes breakage due to crystallization of the teeth.

Cut gears should be meshed as closely as possible by bringing them together square across the face. Using a strip of tissue paper about 0.002 in. thick and a little wider than the face of the gears the alignment and depth of the teeth engaged can be checked. The paper, a few inches long, is placed in a tooth and the gears slowly rotated by hand, pulling the paper through between the teeth. By observing the imprint on the tissue paper, a little experience will soon show if the tooth bears against the one adjacent over the full face and depth. If an extremely accurate meshing of the teeth is required, thinner paper may be used and the gears closely adjusted to produce a slow humming noise when operating at speed. Then, by mixing some fine powdered emery, No. 00 or No. 0, with a good lubricating oil and using this between the gears, operating them at slow speed, a very good meshing of teeth and quiet running will be obtained. E. H. LAABS.

Engineer, Printing Equipment Dept.,
The Cutler-Hammer Mfg. Co.,
Milwaukee, Wis.

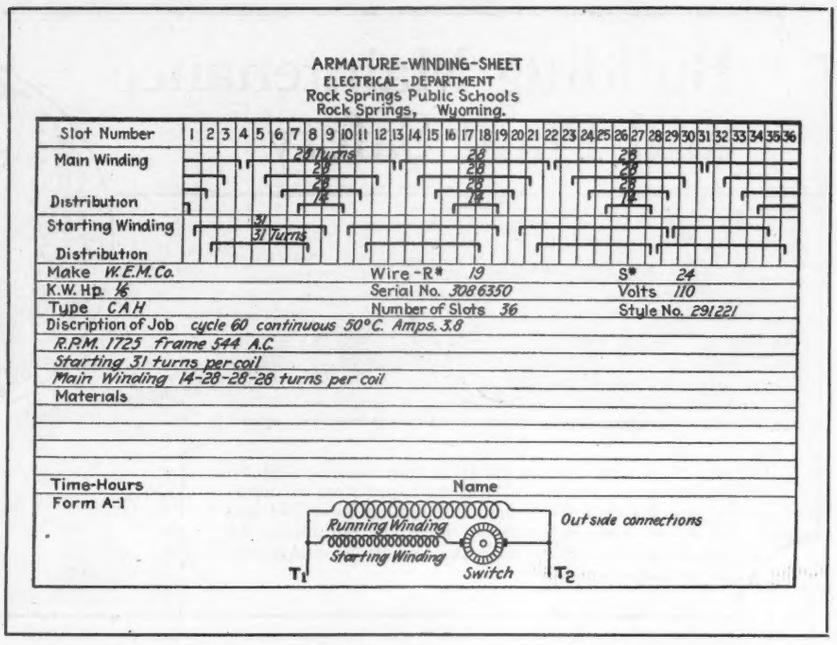
* * * *

Winding Data for Washing Machine Motor—Can some reader supply me with the winding data for a Westinghouse washing machine motor? According to the nameplate this is a 60-cycle, 1,700 r.p.m., motor, 220-110 volts, 2-4 amp. The laminations are 6¼ in. in diameter; the inside bore is 3½ in. and the axial length of the core is 2⅝ in. There are twenty-four slots, ¾ in. deep and ⅝ in. wide. The teeth are ⅛ in. wide at the top and ¼ in. wide at the base. This motor employes a starting winding. I shall appreciate any information which you can give me.

Hercules, Calif. S. McP.

Replying to S. McP.'s question in the March issue for the winding data of a washing machine motor, the accompanying record card gives the data for a similar 36-slot motor, from which the data for the 24-slot motor can be worked out. CHARLES F. CAMERON.

Instructor, Electrical Dept.,
Rock Springs High School,
Rock Springs, Wyo.



Record card for winding data of Westinghouse washing machine motor.

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Rewinding 6-Volt Motor for 110 Volts—I have a Gray & Davis 6-volt d.c. motor which I would like to convert into an electric drill to operate on a single-phase, 110-volt, 60-cycle circuit. Is it possible to rewind this motor? It is equipped with a brush rocker and brush spacing device.

Logansport, Ind. L. E. G.

L. E. G. states in the May issue that he wishes to rewind a 6-volt, d. c. motor to make a drill for operation on 110 volts, 60 cycles. An article by the writer in the May issue will suggest why this is not worth trying. Specifically the reasons are: (1) The field frame would become very hot because it is not laminated and the alternating magnetic flux would set up destructive eddy currents. (2) The number of commutator bars satisfactory for a 6-volt motor is not at all suitable for a 110-volt a. c. series motor. (3) Very little power would be developed during the few minutes that the motor would operate before burning up.

Electrical Engineer, E. L. CONNELL.
Van Dorn Electric Tool Co.,
Cleveland, Ohio.

* * * *

Why Does This Watt-Hour Meter Run Backwards?—I have a 150-kw. motor-generator set driven by a synchronous motor which is operated from a 2,200-volt line. When the set is started why does the watt-hour meter run backwards? The fact that it does run backwards surely does not mean that no power is used in starting. (2) When this machine is running at no-load should the ammeter on the exciter be adjusted so that the watt-hour meter runs very slowly, or so that it stands still? (3) When the watt-hour meter runs backwards, as mentioned, what is the cause of the trouble and what will be the effect? Will it harm the machine in any way? I shall appreciate any information which your readers can give me on these points.

Beaverdale, Pa. M. A. L.

Answering M. A. L.'s question in the May issue, (1) the fact that the watt-hour meter runs backwards when the motor-generator set is started is a definite indication that the meter is incorrectly connected. Assuming that the meter is three phase, it means that one of the elements should have its connections reversed. Of course, power is used in starting as well as when the motor is operating under load, but the fact that the power factor is low and one of the meter elements is reversed causes the element which is revolving, or tending to revolve, in a backward direction to overcome the tendency of the other meter element to move ahead, and thus results in a backward rotation. It is also assumed that the meter is of the polyphase type, that is, all in one case, with the elements on one shaft. Reversal might be caused by a blown potential fuse in one of the meter elements, but I presume that this point has been checked.

(2) At no-load the field rheostat of the motor should be adjusted so that the motor current is at its minimum value; that is, either lowering or raising the exciter current from this value will cause the motor current to increase. With the motor current at its minimum value the watt-hour meter will run very slowly, but will never stand still if it is correctly connected.

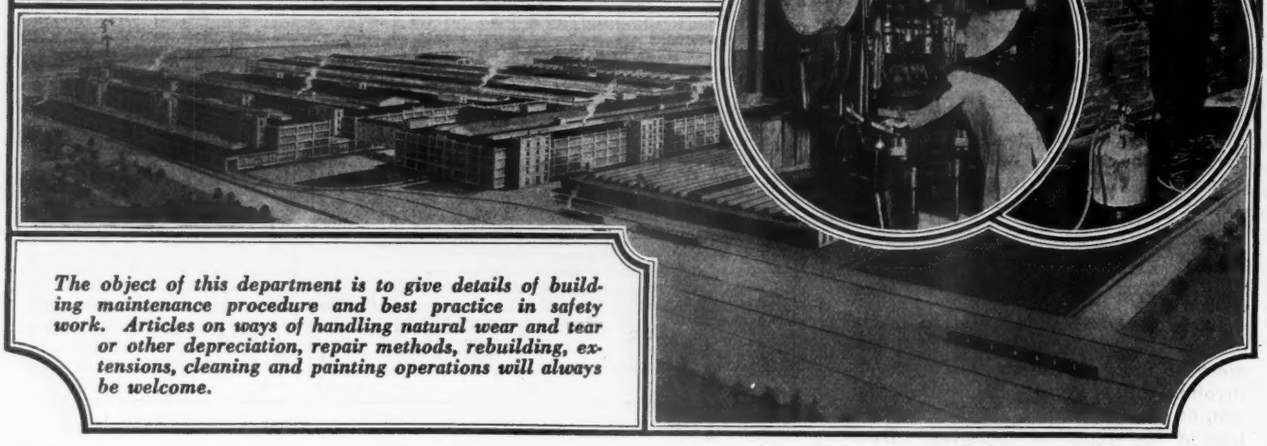
(3) As stated in (1) the meter runs backwards because it is incorrectly connected and the only real effect will be to give a wrong registration of the energy consumed.

It is assumed in the foregoing that there is an ammeter available so that the current put into the motor at 2,200 volts can be read. Definite assurance of the correctness of the watt-hour meter connections can be obtained by operating the motor either at no-load or under load at a number of values of field current which will, of course, be the same as the exciter current if the machine is direct-connected.

C. OTTO VON DANNENBERG.

The J. G. White Engineering Corp.,
New York, N. Y.

Building Maintenance and Plant Safety



The object of this department is to give details of building maintenance procedure and best practice in safety work. Articles on ways of handling natural wear and tear or other depreciation, repair methods, rebuilding, extensions, cleaning and painting operations will always be welcome.

Special Constructed Foundation for Vibrationless Operation

THE PROBLEM of building a foundation which would not transmit any vibration or hum into the building was successfully met in the installation of a steam turbine in a large New York City hotel. Usually preference has been given to reciprocating engines for such installations where noiseless operation is required. The engineers of this hotel preferred to use turbines, if it was possible to do so, and were convinced that if the machines were properly installed, their slight hum could be suppressed. The method used to construct the foundations may be of interest to others who might be called upon at some time to solve a similar problem in a school, or hospital or office where quiet operation is desired.

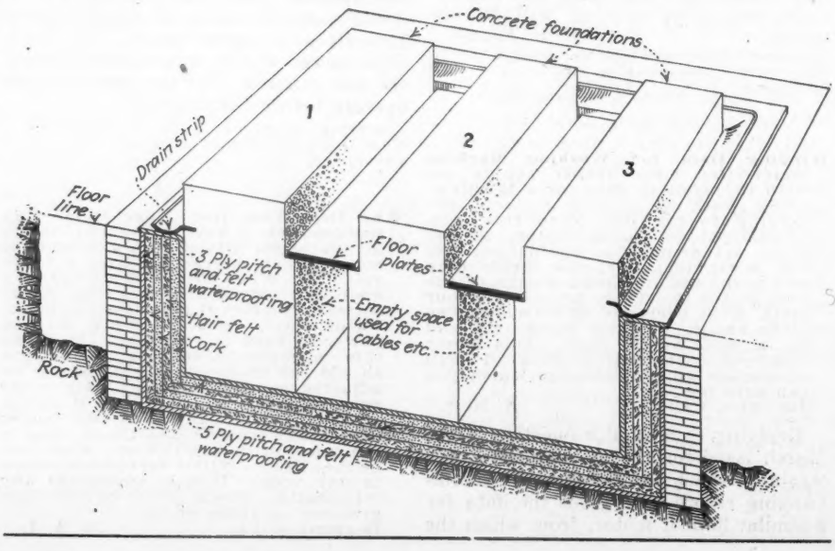
The equipment consists of three 200-hp. non-condensing Westinghouse turbines, each of which drives a 200-kw. 250-volt, direct-current Westinghouse generator. Special attention was given to the turbine foundations in order to prevent the vibrations of these high-speed machines from being transmitted to the structure of the hotel. The foundations were to consist of a concrete block which was to rest on a 2-in. bed of sand and was to be separated from the building's foundations by a thick layer of cork on three sides and an open space on the fourth side.

In spite of these precautions, however, the turbines could be heard in many parts of the hotel as soon as they were started up. The engineers made a thorough examination of the installation and soon located the trouble. In pouring the concrete block, the cement had leaked out into the cork and the sand, and had formed a solid mass, thus destroying the sound-absorbing cushion that had been prepared.

These defective foundations were therefore torn out and new ones, as shown in the accompanying sketch, were laid. The bed rock was levelled, brought to an even surface with cement and the four sides enclosed with 8-in. brick walls up to the floor finish, the walls and floor of the "box" were then waterproofed on the inside with five-ply felt and pitch. A 2-in. layer of hair felt was placed on this bed, with a 2-in. layer of compressed cork on top of that. Then came another layer of felt which was covered by alternate layers of cork and felt so as to make an insulated box on the inner wall of the foundation pit.

These same six layers of insulation were carried up the face of the brick walls to the floor level as well as on the bottom. The interior surface was again waterproofed with five-ply membrane felt and pitch which was carried over the top edge of the side-wall insulation. Into this insulated and waterproof box, concrete blocks were carefully poured. These extended over the side wall insulation, with a brass drip cast into the foundation.

East Pittsburgh, Pa. H. H. LUPINSKI.
Westinghouse Electric & Mfg. Co.,



Details of the construction of a vibration-proof foundation.

When it was desired to insulate a steam turbine foundation from the building so that no vibration would be transmitted this insulated box was constructed and the concrete poured into it. The inner waterproof coating is five-ply instead of three-ply as indicated here.

Wood Blocks Prevent Accidental Closing of Switch

AS A MEANS of preventing knife switches from being closed when repairmen or inspectors were working on motors or other equipment, I used to employ little blocks of hard wood which had a hole drilled in them and were then chiseled out to fit well in the clip of the switch, and tightly enough so that they would not fall off. When a machine was to be shut down for repairs, I would slip these blocks on each clip and as an extra precaution would close the knife blade against the blocks.

When making these blocks the hole should not be drilled all the way through, but only as deep as the clip.

A separate set of blocks is, of course, required for the various sizes of switches.

A piece of string can be fastened on each block and the sets of various sizes kept together on nails in the maintenance department.

Oakland, Calif. S. H. SAMUELS.

Suggestions on Making Shop Floors That Last Under Trucking

FOR MANY purposes new and even concrete floors are most satisfactory for the shop, particularly when there is much transportation of materials. It is not so satisfactory a floor as regards installation of machine equipment or where working on breakable materials, such as castings, which may be dropped and broken. The wear on a concrete floor, by truck wheels, however, eventually occurs in an amount depending on the preliminary treatment of the concrete. Any small crack or slight crevice causes the steel truck wheels to bump and under these circumstances ordinary concrete tends to crumble rapidly.

Floors worn to this condition are expensive to repair because resurfacing with a rich mixture of cement is possible only by removal of one to two inches of the top surface to obtain a bonding surface sufficiently clean and clear of grease to which the top coat will adhere and have body enough to withstand pounding of the truck wheels. While this method has been used in one large plant, it was found necessary, after three years, to remove the concrete in the path of the trucking for the entire depth and rebuild that section of the floor.

To prevent this rapid wear another plant has adopted for the concrete floor a surface treatment which consists of several coats of boiled linseed oil thinned with gasoline. This mixture apparently penetrates the pores of the concrete and forms a gummy bond which resists wear, as the floor has given six years of service and still is in good condition. An additional advantage is that this floor is practically free of dusting, which is objectionable in that it is detrimental to open machinery.

Wooden floors laid over concrete have protective qualities which are desirable in many machine shops. Breakage of parts dropped on them is infrequent; they are sound deadening to a large extent and considerably more comfortable from the workman's standpoint. Ordinarily wooden floors wear for long periods when the trucks are run mostly in line with the grain of the wood. Splintering is only apparent with heavily loaded trucks or after long use. Oak flooring will splinter more rapidly than maple, which is possibly the most desirable of any of the woods for shop floors. In placing shop floors, the practice generally is to use a double floor with the upper section laid at right angles or across the under surface. To repair any splintered floor, the top section of the floor is removed and replaced with new material. When it is evident that truck paths are across the grain, thus causing rapid splitting or splintering of the wood, the floor may be repaired by placing the top section longitudinally to the truck paths, regardless of the sub-flooring.

In some shops where the combination of wear and weather at the edges of the entrance doors causes rapid destruction of the wooden flooring a special concrete mixture has been adopted with considerably more success than was had with the wood. This repair consists of the entire removal of the wood, laying a 10-in. tamped cinder bed and filling for a depth of 8 in. with cement, iron dust and sand in the proportions of 20 parts of iron dust to 100 of cement and 200 of sand. This cement has shown remarkable resistance to wear, is waterproof and provides a good gripping surface for rubber-tired motor truck wheels, and the steel wheels of the hand trucks. Likewise it affords a dependable footing for stepping on in wet weather, as it is not slippery at any season.

Washington, D. C. G. A. LUERS.

[NOTE: The Editors would appreciate comments from readers on their experience in repairing wooden and concrete floors to take care of trucking wear. Should trucking be with, across or diagonal to the grain of wooden floors?]

Practical Safety Pointers and Possible Penalties Inflicted on Those Who Take a Chance

By H. S. RICH

New Britain, Conn,

With his own illustrations.

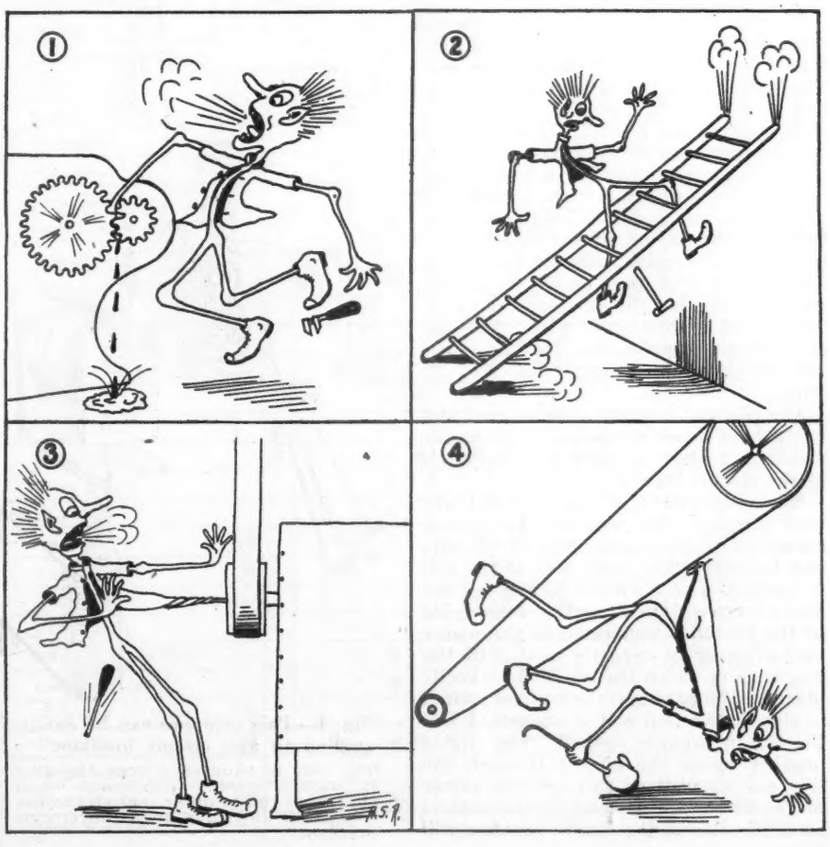
(1) One of the most dangerous things about a plant is an exposed gear on a machine in operation, for when it once gets a hold on a person's limb or clothing there is no getting away from it. A belt on a pulley may slip off or break just as some large obstruction gets caught under it, but not so with a gear; it just grinds and crushes away unmercifully.

An oiler or some mechanic may have his hand resting on a gear, not thinking about how easy it is to get hurt, when suddenly, somebody starts the machine, and quick as a wink, that hand is caught. Keep your hands off gears, even when idle. Gears should be entirely encased with some provisions for opening the guard to be safe.

(2) A ladder without sharp spurs is a risky thing on a smooth, oily or wet floor. A ladder with spurs can be held securely on a smooth floor by resting it on a wide board. A few small nails only are needed to hold it.

(3) A pulley with a protruding key is also quite dangerous, and will wind up a person's clothing in jig time, perchance it gets a grip. Drive keys in until they are tight and cut them off flush or round the end over with a file.

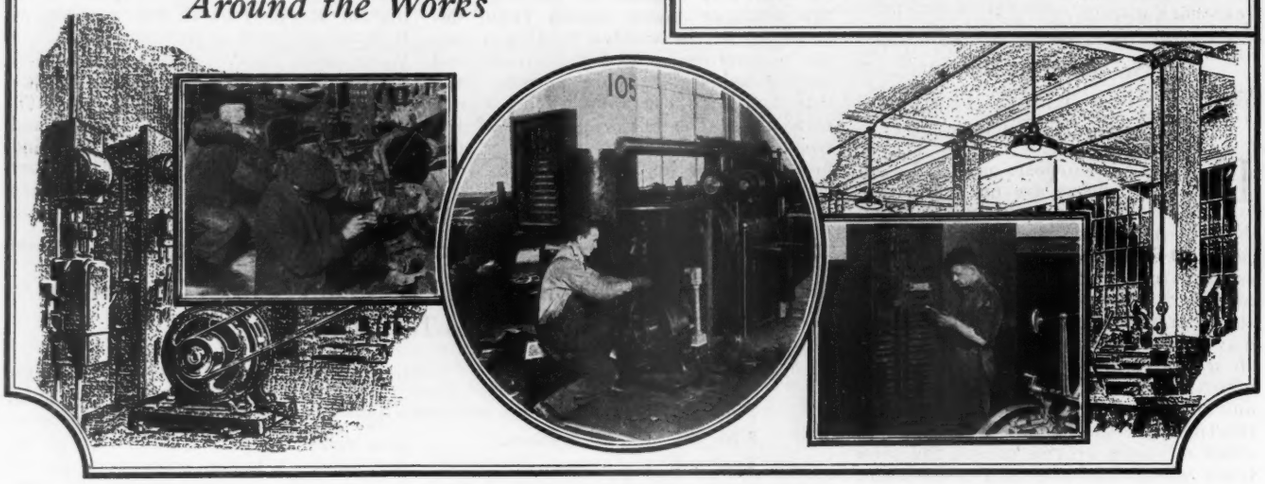
(4) A belt with metal or wire fastenings is liable to get hooked on your clothing or the waste in your hand if in the danger zone. A belt with a loose inside flapping edge will also give your hand an awful rap, while applying belt dressing.



Electrical Service

Around the Works

For this section ideas and practical methods devised to meet particular operating conditions are invited from readers. The items may refer to inspection, overhauling, testing or special installations.



Easily-Made Trip Coil For Remote Control Of Motors or Feeders

OFTEN it is desired to stop a motor or open a circuit from a distant point and yet not run heavy leads to the desired point. Also, in the case of a motor driving a group of machines, it is frequently necessary to be able to stop the motors from several different points. If the motor or circuit is controlled by a circuit breaker, the trip coil herein described may prove to be the solution of the problem.

In Fig. 1, the trip coil is shown mounted on brackets below the overload trip latch of the circuit breaker. The plunger of the trip coil rises and hits the latch of the circuit breaker, thus opening the circuit. In Fig. 2 the construction and dimensions of the trip coil are shown. As can be seen, the spool is made of brass. The cylindrical portion of the spool is insulated with three to five layers of varnished cambric and the inside ends of the spool are covered with four or five layers of paper 0.010 in. thick. The spool is wound full with magnet wire. For use on 110-volt supply, use No. 29 wire; for 200-500-volt supply, use No. 32 wire.

The plunger is made of mild steel and has a hard wood extension at its upper end long enough to reach the trip latch of the circuit breaker.

The connections of the trip coil are very simple. One end of the coil is connected to the motor side of the circuit breaker. The other side of the coil is connected to a switch located at the desired control point. The other side of the switch is connected to the motor lead of polarity opposite to that of the line wire in which the circuit breaker is placed. Hence, when the control switch is closed, the trip coil is energized and the circuit breaker opened. The circuit breaker opens the circuit through the trip coil as well as through the motor or feeder; hence as long as the control switch is closed, the circuit breaker will remain open. The trip coil may be controlled from several different points by connecting control switches in parallel with the first one. This feature is of particular value when it may be necessary to shut down the drive in an emergency, for the control switches can be located at convenient points.

The trip coil and switch may be used as a safety feature. When only one control switch is used, it may be enclosed in a box with a hasp and lock on it. With the switch closed and the box locked no one, except the man with the key to the box, can start the motor, inasmuch as the circuit breaker will not stay closed as long as the control switch is closed. This will prevent starting the motor while some one is working on the drive.

I have used this coil for several years and have had very little trouble with it. It can be used on 220, 440 or 500 volts alternating current or direct current without any change in connections or the winding of the coil. For 110 volts, the coil works best with the larger size of wire, No. 29, mentioned above.

Chief Electrician, ERNEST J. FORD.
Kewanee Boiler Company,
Kewanee, Ill.

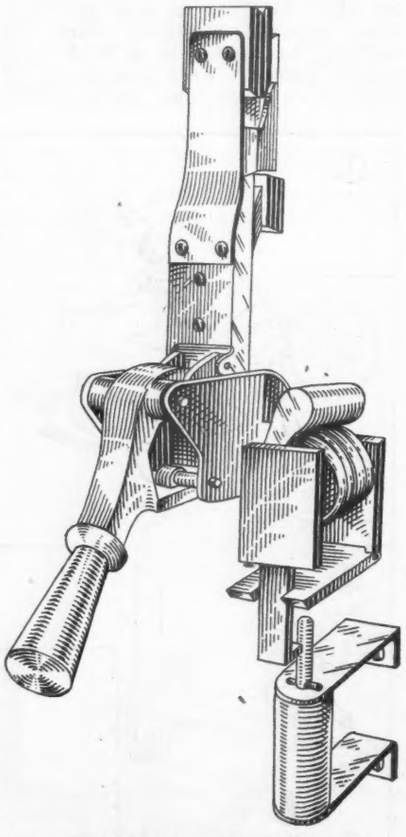


Fig. 1—This trip coil can be easily applied to any circuit breaker.

The coil is shunted across the line through a control switch and when energized the plunger will strike the trip latch and thus open the circuit breaker.

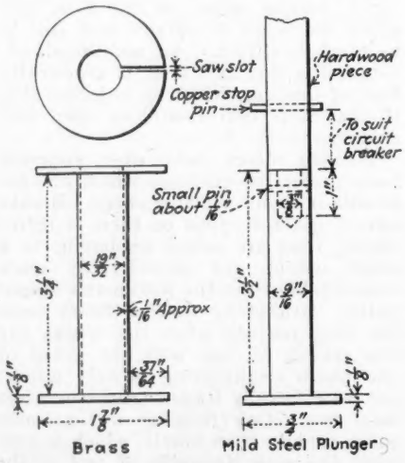


Fig. 2—The spool of the trip coil is made of brass.

The dimensions are shown at the left of the diagram. On the right is shown the construction of the mild steel plunger which is actuated by the coil. At the upper end of the plunger is an extension made of hard wood which should be long enough to reach the trip latch of the circuit breaker.

Keeping Idle Generators Warm to Prevent Condensation

FROM past experience with generator winding breakdowns, C. Monson states in the April number of the Journal of the American Institute of Electrical Engineers that he believes many of these breakdowns have been due to moisture or water getting into the machine, causing concentration of corona on the winding where drops of water were located.

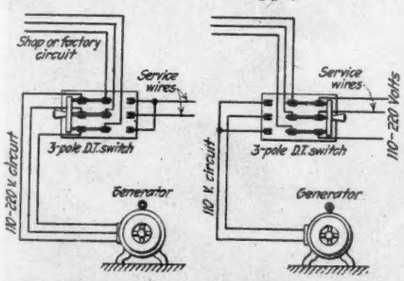
Generators may be shut down frequently from one cause or another, such as lack of load, repairs, cleaning and the like. If the generator when idle is allowed to cool off below the room or ingoing temperature, or if a generator is of the enclosed type taking air from outside the building or from the basement and discharging it to the outside, heating it up by a quick change in temperature either when standing still or when started up with load will result in the condensation of moisture both in the stator and the rotor, the water dripping all over the winding.

This water is the cause of considerable trouble from corona after the generator is started and running with full potential. From tests that have been made it has been found that these drops of water will show fire with relatively low voltage in the coils and that the fire increases in density with increased voltage. It is thus only a matter of time before the winding is injured sufficiently to break down at its weakest point.

To safeguard against this enemy of the generator when idle, it is suggested that the machine be kept moderately warm at all times, slightly above the temperature of the room or ingoing air. This can be done in several ways, such as installing steam pipes in the air entrance or in the shields, by the use of electric heaters or by circulating a current through the windings.

Cutting Over from 3-Wire to 2-Wire Supply

MANY factories are wired for three-wire, 110-220-volt service and have an outside emergency supply which is two-wire, 110-volt. A convenient means for quickly changing from one supply to the other is shown in the accompanying diagram. The scheme shown on the left is for use when the outside emergency supply is two-wire and the plant system is three-wire; the scheme on the right is for use when the outside supply is three-wire and plant generator is two-wire.



By means of the three-pole, double-throw switch, transfer of a circuit may be made from a three-wire, 110-220-volt supply to a two-wire, 110-volt supply.

As can be seen from the diagram, a three-pole, double-throw switch is used, the middle poles of which are connected to the shop or factory circuit which it is desired to transfer from one supply to the other. On the two-wire end of the switch, the two outside switch jaws are connected together and to one side of the 110-volt line. The center jaw is connected to the other side of the 110-volt line. When the switch is closed on the two-wire side, the shop circuit will have 110 volts impressed between the two outside wires and the middle wire.

This will supply all of the 110-volt equipment operated in the shop. If the shop circuit has any 220-volt motors connected across the two outside wires, this system will not, of course, supply them, inasmuch as only 110 volts are available and the two outside wires are of the same polarity. However, on most three-wire, 110-220-volt systems, used in factories, only 110 volts are taken from the wires; consequently, this scheme of transferring from one supply to the other will prove very convenient.

New York, N. Y. DONALD L. HOARE.

Industrial Applications of Synchronous Motors

OPERATING men in various industries who may be considering the possibilities of the use of synchronous motors to improve their power factor will be interested in the accompanying chart. The column at the left lists the common industries and the headings show the different equipment in each of those industries which is best adapted to the use of synchronous motors. It is interesting to note that in this chart, as arranged by the Electric Machinery Manufacturing Co., Minneapolis, Minn., centrifugal pumps seem to be the type of equipment in the largest number of industries which is most suitable for the application of synchronous motors.

With this chart an industrial man may check the possibilities of the use of synchronous motors.

While this chart shows the equipment ordinarily found in these industries some special occasions may arise where other equipment, which could also use synchronous motors, may be in use in some particular plant. It is always best, however, to refer any installation back to the manufacturer of the synchronous motor for his recommendations.

INDUSTRIES	Air Compressors	Ammonia Compressors	Ball Mills	Blowers	CO_2 Compressors	Centrifugal Pumps	Fans	Frequency Changers	Conveyors	Grinders	Jordans	Line Shafts	Motor Generator Sets	Pulp Grinders	Plunger Pumps	Rubber Rolls	Crushers	Tube Mills
Automobile	●			●			●				●	●						
Brick and Clay						●			●		●							
Cement Plants	●		●	●			●				●							●
Cereal Mills		●				●	●		●	●	●			●				
Cooling					●		●											
Drainage Projects						●												
Dredges						●												
Electric Lt. & Pr.								●				●						
Flour Mills							●		●		●							
Foundries	●			●														
Grain Elevators							●		●		●							
Ice and Refrigeration	●	●				●												
Iron Works	●			●								●						
Irrigation Projects						●												
Lumber Mills											●							
Marble and Stone Works	●										●							
Metal Working	●			●							●	●						
Mines	●					●	●		●					●		●		
Oil Refineries						●								●				
Packing Houses		●				●	●		●	●								
Paper Mills						●				●	●	●	●					
Pulp Mills						●				●			●					
Quarries	●					●			●							●		
Railroad Shops	●			●							●	●						
Rock Crushing									●	●	●					●		
Rubber Mills															●			
Sand and Gravel Works						●			●									
Sewage Disposal						●												
Shipyards	●																	
Steel Mills	●			●		●	●				●	●		●		●		
Textile Mills											●							
Water Works	●					●								●				
Wood Working				●							●							

Mechanical Maintenance of Power Drives

This department will furnish mechanical details of installation, operation and maintenance of equipment in the path of power service from the first mechanical driving element through transmitting equipment to all driven machines.

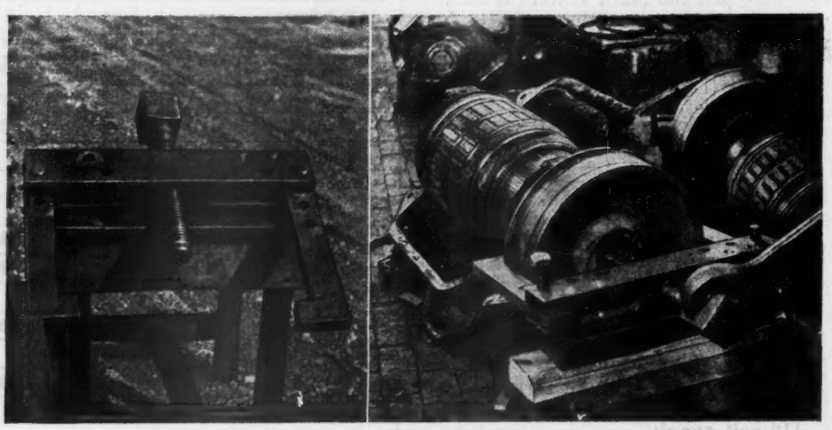
Easily Made Device for Pulling Off Pinions and Brake Wheels

WHILE there are many devices on the market that are very convenient for pulling off brake wheels and pinions, here is one that can be made in any machine shop.

It consists of four parts made of steel bar: the jack screw, the cross bar, and the two legs which engage with the pinion or brake wheel. The jack screw shown in the illustration on the left is 1 ft. long and 1½ in. in diameter. The cross bar is drilled and threaded to fit the jack screw. The cross bar is made from a steel bar 3 in. wide, 3 in. thick and 18 in. long. If brake wheels larger than 15 in. in diameter are to be pulled, the cross bar should be longer than 18 in. The cross bar is slotted at each end to receive the legs, as shown in the left-hand illustration. The legs are made of steel bar 1 in. thick, 2 in. wide and 12 in. long. The ends of the legs are notched as shown so as to engage with the brake wheel or pinion. Holes 11/16 in. in diameter are drilled in the legs and in the cross bar; these holes permit adjustment of the device to suit the size of the brake wheel or pinion it is desired to pull. Bolts ⅝ in. in diameter are used to fasten the legs and cross bars together.

The illustration at the right shows the manner of using the device. Blocking is put underneath the cross bar to keep it from turning when the jack screw is tightened against the armature shaft. The jack screw should be tightened with a long-handled wrench; a piece of pipe may be put over the wrench handle to make it longer. It often helps to start the brake wheel if the hub is pounded, after tension has been applied by tightening the jack screw. In very stubborn cases, the hub of the wheel may be heated with a blow-torch or acetylene flame.

Chief Electrician, O. C. CALLOW.
Trumbull Cliffs Furnace Company,
Warren, Ohio.



This device for pulling brake wheels or pinions is made from steel bar and is adjustable for the different sizes of wheels or pinions.

Safety Suggestions for Workers Around Shafting

SAFETY SUGGESTIONS for those who work about revolving shafting are given below. Not only does the observance of these make for personal safety, through the reduction in the number of minor and serious accidents, but it reduces maintenance costs through avoiding loss of time and broken belts. All of these increase plant efficiency.

Don't have pulleys too close together. There should be a space between adjacent pulleys equal to double the width of the wider belt used upon those pulleys.

When a belt is thrown off a pulley to remain off for any but immediate repairs, it should be hung upon a belt perch installed for the purpose. It should never hang upon the revolving shaft.

All belts that are replaced on revolving pulleys should be put on with a belt stick, or pole. If a belt cannot be put on that way, stop the shaft or wait until it is stopped and then apply it by hand at a speed of not more than 15 r.p.m.

Wood pulleys sometimes get chipped; usually one of the laminations only is knocked out. Such jagged edges are as dangerous as projecting set screws and should be filled immediately.

Two pulleys ought never be placed together, unless this is done to make one wider pulley for one belt only. When two belts are run from close-up pulleys, breaking of one belt invariably results in its getting wound up in the other one.

When split pulleys are installed, see that the joint edges are evened up. The overlapping edge at the joint may catch on and tear a belt or cause injury to the hand of a beltman.

Inspect belts periodically and repair broken fastenings and loosened laps.

Do not use a ladder against a revolving shaft unless it has safety feet and top hooks.

Oil all shaft bearings and as many loose pulleys as possible when the shafting is not running.

On pulleys over 16 in. in diameter, which are held by setscrews, protect the screws by safety collars or other

guards. The mere fact that setscrews are "within the boundaries of the rim" does not remove the hazard where there is sufficient space between hub and rim for the arm to enter.

Never work about moving shafts with loose clothing, particularly loose sleeves.

Do not thrust arms through spaces of a pulley, even though the shaft is idle; someone may start it moving.

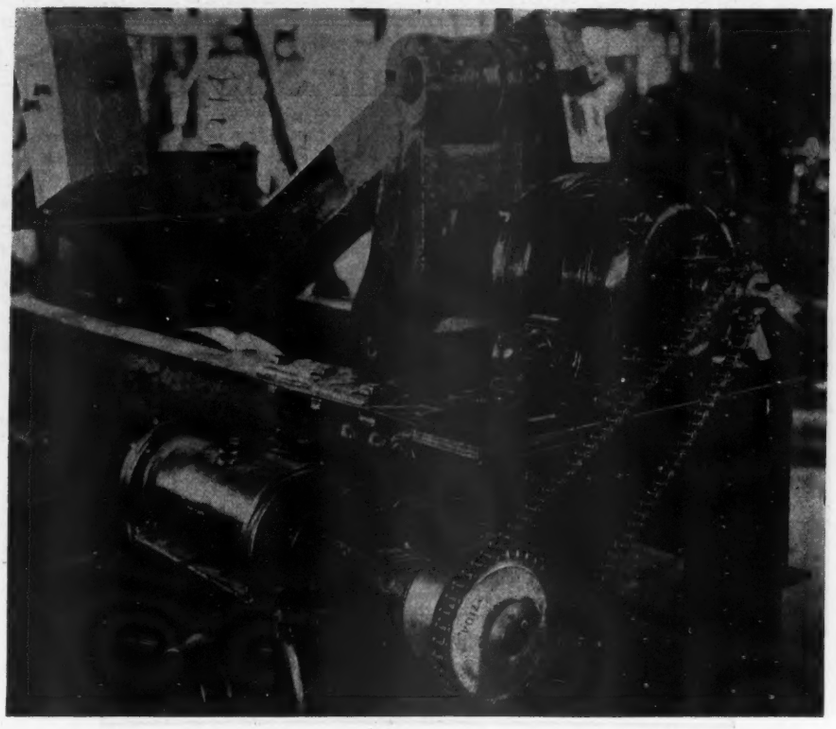
DONALD A. HAMPSON.
Plant Superintendent,
Morgans and Wilcox Mfg. Co.,
Middletown, N. Y.

Roller Chain Solves Unusual Drive Condition

ONE of the recent improvements made in the drive on our balers, used for baling scrap metal, leather, rags, paper, cotton and the like, was to replace the type of chain drive in use on the worm shaft drive with roller chains made by the Diamond Chain and Manufacturing Co., of Indianapolis, Ind. An unusual characteristic of the drive on these balers is the use of high-torque motors which give the chain a terrific jerk when starting and then, as the bale is compressed, the motor slows down until the current is automatically cut off just before it reaches a dead stop. This cycle is repeated every time a bale is made.

Two sizes of balers are used: A small baler on which the maximum chain pull amounts to 600 lb. and a larger baler on which the maximum pull amounts to 1,000 lb. The small motor develops a maximum torque of 70 ft.-lb. and we are using a roller chain with ⅝-in. pitch, ⅜ in. wide. The larger motor develops a 140-ft.-lb. torque and we are using on it a roller chain with ¾-in. pitch, ½ in. wide. The length of chain varies with the different balers but averages 5 ft. The motor sprockets have fourteen teeth and the chain speed runs as high as 1,400 ft. per minute.

This substitution resulted not only in a saving in first cost, but also a saving in maintenance costs. The saving in first cost amounted to $16.75 per baler. This saving of $16.75 per baler plus a saving of $2.00 in the cost of the sprockets, amounts to $5,625.00 per year on our production of 300 machines. In 2½ years of use we have had only one replacement and this was due to letting a piece of wood get between the chain and the sprocket. With the exception of this instance, we have not had a cent's worth of repairs to chains or links.

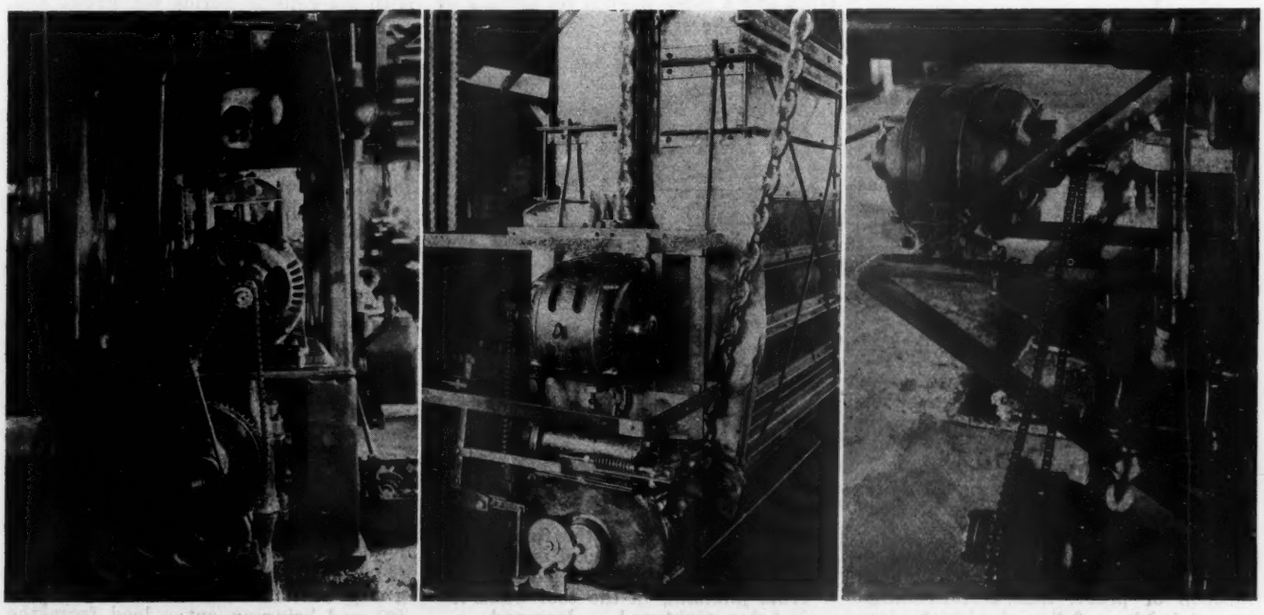


This drive is subjected to a terrific jerk when the motor is started.

As the load cycle is continued the motor slows down under the heavy load until the current is automatically cut off before the motor comes to a dead stop. This chain drive operates a baler.

The superior results obtained with the roller chains are due to the fact that they run very satisfactorily under adverse conditions. Dust, dirt, and poor lubrication are not especially harmful. We are so thoroughly sold on roller chain that we are now using it in our factory to drive machines. In this work it is giving excellent service, runs quietly, and has a long life.

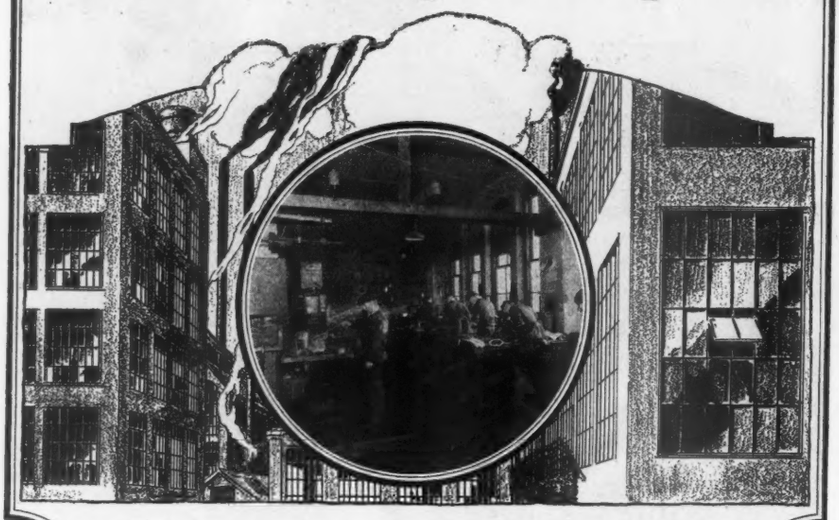
A. C. BURROWS.
Chief Engineer,
Economy Baler Company,
Ann Arbor, Mich.



Three applications of roller chain.

On the left is the drive on a 42-in. boring mill. The motor used is 7½ hp., 1,800 r.p.m. In the center illustration the roller chain connects a 5-hp. motor with a 50-ton, waste-paper press. On the right is a 5-hp. motor driving a boring and drilling machine through a roller chain.

In the Repair Shop



This section is devoted to repair work, large and small. Special attention is given to shop or bench tools and short cuts or improved methods. Contributions are always welcome.

The Drying Through of Baking Insulating Varnishes

I HAVE read an article appearing in the July issue of INDUSTRIAL ENGINEER entitled, "When Analyzing Coil Insulation Troubles," by H. L. Hazeltine, Engineer of Insulation, The Sterling Varnish Company, Pittsburgh, Pa.

I feel that it is unfair for manufacturers of insulating varnishes to make such statements as appear in the article, under the sub-heading of Baking Varnishes, page 333. Under this heading the writer states:

"Some materials have been sold on the claim that they will dry from the inside out and that, therefore, drying can be obtained all the way through. These materials have not been a success as it has been definitely proved that they will also form a skin, over the outside surface, and, when such a skin is formed the oxidation of the varnish base is stopped. Rather than select a material which must be sold by false claims it is much wiser to see what can be done towards remedying the difficulty by a proper method of treating the coils after the varnish has been applied."

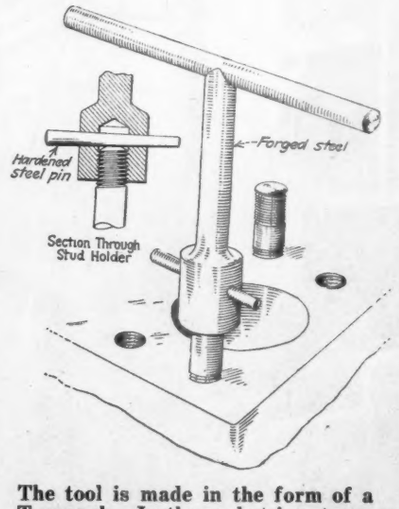
In our advertisements we make the statement that "Chinalak Black—bakes through." The writer has been connected with the manufacture and sale of insulating varnishes since 1897 and has tried to keep abreast of technical developments in the art. We were the first company in this country, or in the world for that matter, to make use of China wood oil exclusively in the manufacture of insulating varnishes. Our products carry the experience of many years, are carefully made and the best raw materials obtainable are used in their manufacture.

My chief objection to this reference is the positive statement, without submission of proof, that certain things cannot be done, followed with the intimation that anyone making such claims is selling his product under false pretenses. The writer of the article may say that he does not refer particularly to our product, but so far as I know our company only, has come out and made the positive statement that we supply a varnish that "dries through," and we stand ready to prove this to anyone who is legitimately interested.

President, JOHN C. DOLPH.
John C. Dolph Company,
Newark, N. J.

Simple Tool for Screwing in or Removing Stud Bolts

WHILE various types of stud tools are in use, these invariably require some form of separate threaded block and a loose wrench for driving or removing the stud.



The tool is made in the form of a T-wrench. In the socket is a taper pin which serves to keep the stud from jamming in the tool when it is being tightened or loosened.

A simple tool which is designed to accomplish the separate operations of screwing in or removing a stud bolt, is shown in the accompanying illustration. As may be seen this tool is made up as a T-wrench which is threaded to agree with the stud. At the bottom of the threaded opening is a driving taper pin, the purpose of which is to hold the stud from screwing too tight in the socket. By driving this taper pin in solid with the hammer when the stud is screwed up to it the stud bolt is held firmly and can be screwed in or out of place without loosening. The stud is readily released so that it may be screwed out of the T-wrench by a single blow of the hammer on the small end of the taper pin.

Washington, D. C. G. A. LUERS.

Four-Speed Motor Changed to Single Speed and Different Voltage

A LARGE manufacturing company had a 10-hp., 220-volt, three-phase, 60-cycle, four-speed (600-900-1,200-1,800 r.p.m.) motor that was not being used. When a call came in for a 10-hp., 440-volt, 900-r.p.m. motor it was decided to investigate the four-speed motor and determine whether the 900-r.p.m. winding could be reconnected for 440 volts.

Four-speed motors have two separate windings, each winding giving two speeds; that is, one winding is arranged to develop 900 and 1,800 r.p.m., with four and eight poles and the other winding gives 600 and 1,200 r.p.m., with six and twelve poles.

Investigating the bottom or four- and eight-pole winding, it was found that the four-pole (salient) winding was connected series-delta, seven leads being brought out as in diagram (A). The coil pitch was 1-and-10, which is 50 per cent pitch for four poles and seventy-two slots. The winding was found to be arranged in twelve groups with six coils in series per group and four groups per phase. The winding consisted of eight turns of two No. 15 silk-and-enameled wires in parallel. Notice that in diagram (A) the arrows on adjacent pole-phase groups point in different directions. For the eight-pole winding the leads are changed as shown in (B), which gives an eight-pole (consequent pole) winding; or, in other words, four pole-phase groups develop eight poles. The connection is changed to two-parallel star on the eight-pole winding and arrows on all pole-phase groups point the same direction.

Since it was desired to operate this motor on a 440-volt line, and at 900 r.p.m. it meant that the motor must be reconnected series-star for 440 volts, and still maintain the eight-pole (consequent pole) winding. From a study of the small diagram under (B) it will be seen that by opening connection (14) between groups (12) and (3), and also jumper (1) between groups (6) and (1), and then connecting the end of group (6) to the beginning of group (3) and bringing out a lead from the

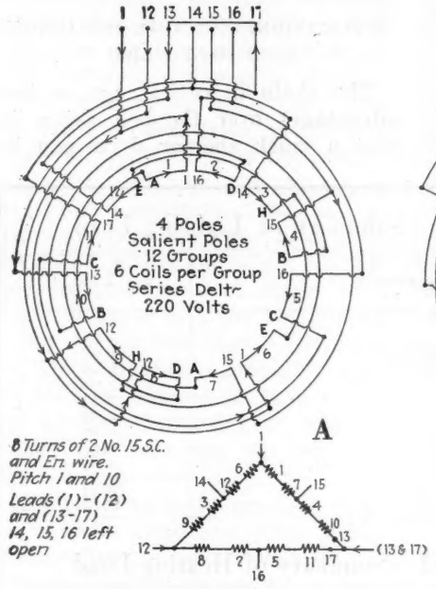
beginning of group (12) and calling the end of group (9) the star connection, we will put all four pole-phase groups of one phase in series as is shown in the small diagram under (C) and also maintain the proper polarity of each pole-phase group. The same thing can be done to the other phases. This will give a series-star, eight consequent-pole winding for 440 volts.

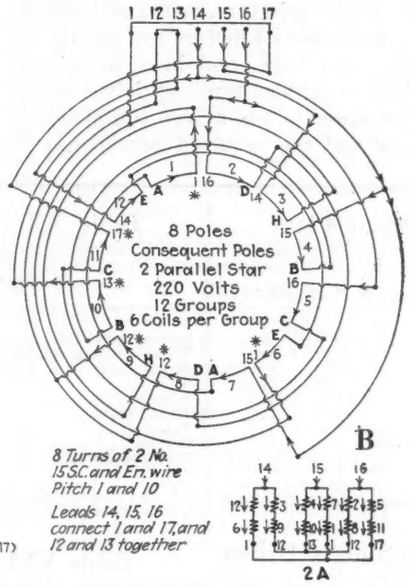
The resulting series-star connection is shown in (C). The groups are numbered the same as in (B) and the heavy figures show where the lead jumper has been opened and changed to a group jumper. Also leads (14), (15) and (16) are still attached to the beginning of groups (12), (4), and (2) as in diagram (B). One end of lead (12) is used as a star connection, as is also lead (1). Lead (17) is not changed. With this connection six leads can be brought out and the star connection made outside, or the star connection can be made inside the motor and only three line leads brought out. When using only one winding be sure that the other winding is open-circuited; otherwise the eight-pole winding will set up a current in the six- and twelve-pole winding by transformer action.

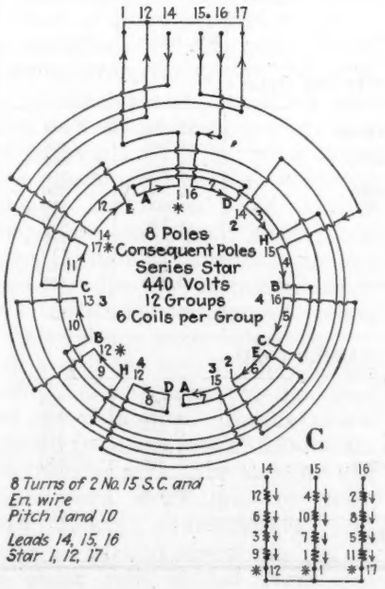
The motor was reconnected as shown in diagram (C) and ran satisfactorily for a long period. When the motor finally burned out it was decided to rewind it and only put in one winding, thus doing away with the unused winding. It was rewound for a rating of 10 hp., 440 volts, three phase, 60 cycles, 900 r.p.m., and eight poles. As stated before, the four- and eight-pole windings consisted of seventy-two coils of eight turns of two No. 15 silk-covered, enameled wires per coil, pitch 1-and-10, or 100 per cent pitch for eight poles.

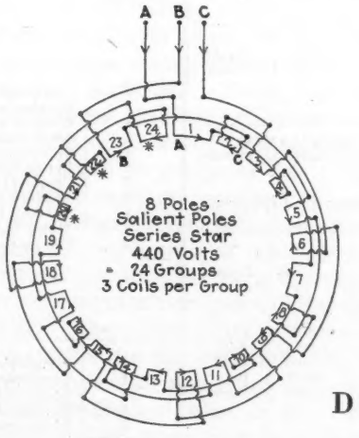
Diagram (A) shows the original 900-r.p.m. winding while (B) shows the connections for 1,800 r.p.m.

In (C) the connections are changed so as to give 900 r.p.m. at 440 volts instead of 220 volts. Later when the motor was entirely rewound, the winding and connections shown in (D) were used.




8 Poles
Consequent Poles
2 Parallel Star
220 Volts
12 Groups
6 Coils per Group
B
8 Turns of 2 No. 15 S.C. and En. wire
Pitch 1 and 10
Leads 14, 15, 16 connect 1 and 17, and 12 and 13 together
2A





With the eight consecutive-pole, 440-volt, series-star connection, there were four groups of six coils per group or twenty-four coils in series per phase and each coil had eight turns. Then the number of turns per phase is equal to $(8\times24) = 192$. On rewinding the motor, it was decided to group and connect the winding in the standard manner; that is, with eight salient poles or twenty-four groups of three coils per group. Then, using eight turns of two No. 15 silk-covered and enameled wires per coil, the same as before, the number of turns per phase would be $(8\times3\times8) = 192$, or the same as with the consequent-pole grouping.

Since the coils of the original four- and eight-pole winding were wound with eight turns of two No. 15 wires in parallel and since there were two coil sides per slot, this winding had a total of $(2\times8\times2) = 32$ wires per slot. The coils of the original six- and twelve-pole winding were wound with ten turns of two No. 15 wires in parallel and since there were two coil sides per slot, this winding had a total of $(2\times10\times2) = 40$ wires per slot. Hence each slot contained four coil sides with $(32+40) = 72$ No. 15 wires.

With the single winding there would be only $(2\times8\times2) = 32$ wires per slot; therefore we can use eight turns of three No. 15 silk-covered, enameled wires per slot. This would make a cooler running motor.

The final rewinding data was eight turns of three No. 15 silk-covered, enameled wires in parallel, pitch 1-and-10, connected series-star, as in (D).

Detroit, Mich. A. C. ROE.

Wire Solder May Be Used as French Curve In Emergency

RECENTLY while making a drawing I found it necessary to use a spline or adjustable curve. As I did not have one at the moment, it was necessary to use the next best thing, a piece of ordinary wire solder. It served well and now finds a place in my drawer, with the other drawing instruments.

I find that it is indispensable for drawing large and odd-shaped curves and it often fills a want where a French curve will not fit. It is perfectly flexible, yet holds its shape when once formed. Further, the ruling pen easily follows the curve and because of the circular cross section of the wire, the ink will not spread under the curve and thus spoil a drawing.

Hard solder is preferable for this purpose as it holds its shape better than the soft variety and is less likely to kink while the curve is being formed. When using a piece of wire solder for this purpose, form the wire along the pencil curve and place two or more paper weights or other small objects on the solder to prevent movement. Then rule the curve between the weights. When the ink dries move the weights and complete the ruling of the curve.

Oakland, Calif. S. H. SAMUELS.

Details of Paper Mill Drives

(Continued from page 367)

large size of the motors (600 hp. up) belt drive is out of the question on account of space. Direct drive in this department is the only type of drive feasible.

On elevator legs of the bucket type, the motor is sometimes direct connected to a shaft in the top of the leg, to which is keyed the sprocket which carries the chain. As the space at the head of the leg is usually limited, direct drive is the most suitable type.

Direct drive is also used on agitators, or mixing tanks. Since these tanks are usually open at the top, the motor is likely to be flooded at any time and belts and other types of drive are inconvenient. The drive is usually horizontal, the shaft terminating in a bevel gear at the center of the tank. Reduction gears are often used in this capacity, but since they are usually part of the agitator equipment, the drive may be called the equivalent of a direct drive.

There are several types of gear drive. Those most commonly used are the spur, bevel, worm and herring-bone. The latter type of reduction gear is the best, as it is practically noiseless in operation and can be run at extremely high speeds—5,000 r.p.m. and over.

Where paper machines are of the sectional types, such as the Harland or General Electric, reduction gears are used between the motor and the particular section being driven. While the gear occupies nearly as much space as the motor, the motor frame size is much smaller, owing to the higher speed, since the higher the speed of a motor the smaller the frame size for a given horse-power output.

Bevel gears are advantageous where the drive is changed in direction, say horizontal to vertical drive, as on the agitators, mentioned before.

Back-geared motors are usually of the spur type, and have an advantage over most types of drives where the speed of the driven equipment is low and the required horsepower is small. An example of this kind is seen in a save-all, which is a revolving wire cylinder provided with slats to gather the stock from the water going to the sewer. The speed of the cylinder is usually not more than 40 to 50 r.p.m., and the required horsepower is from 3 to 5. With motors of this size at speeds of 720 to 1,200 r.p.m., the cost of the motor is low, the gears cost much less than line-shafting and belt, the unit occupies very little space and can be housed from dampness.

This type of drive is also used to some extent on elevator buckets where the heat would be ruinous to a belt, as is the case with the sulphur burner.

Worm-gear drive is probably used most in pulp and paper mills in connection with freight and passenger elevators and is the only practical drive for this service.

Applications Suitable for Chain and Belt Drive

The chain drive has one or two advantages over the belt drive, in that a much shorter drive can be

Table XVII—Drive Data of Steam Plant

Duty	No. of Motors	Type	Hp. Rating	R. P. M.	Drive
Refuse conveyor	1	S. C.	10	600	Belt
Stoker drive	1	S. C.	1	1,200	Belt
Blower	1	S. C.	75	1,200	Direct
Coal elevator	1	S. C.	7.5	720	Gear
Coal conveyor	1	S. C.	7.5	1,200	Belt
Coal crusher	1	S. C.	30	720	Belt
Ash conveyor	1	S. C.	10	1,200	Belt
Total	7		141		

All of the above motors are three-phase, 550-volt, squirrel-cage(S.C.) motors.

Table XVIII—Data on the Water Supply Drives

Duty	No. of Motors	Type	Hp. Rating	R. P. M.	Drive
Low-head pumps	3	S. C.	75	1,200	Direct
High-head pumps	3*	S. C.	175	1,160	Direct
Total	6		750		

*One of these motors is a spare. Never more than two running at a time.
All of the above motors are three-phase, 550-volt, squirrel-cage(S.C.)motors.

Table XIX—Data on the Miscellaneous Drives

Duty	No. of Motors	Type	Hp. Rating	R. P. M.	Drive
Synchronous condenser	1	Sync.	495	600	.....
Portable air compressor	1	S. C.	5	1,800	Belt
Air compressor	1	S. C.	15	860	Belt
Machine shop	1	S. C.	20	600	Belt
Concrete mixer	1	S. C.	10	1,200	Gear
Total	5		545		

All of the above motors are three phase, 550 volt.
The actual load taken by the condenser is 50 hp., so that the actual load of the miscellaneous motors is 100 hp., with the average at 70 hp.

Table XX—Summary of Lighting Load

Department	Kw. Load
Ground-wood mill	2.75
Wood handling, sulphite mill	4.07
Steam plant	4.95
Yard	12.00
Sulphite mill	12.87
Bleach plant	2.20
Paper mill	34.48
Stables	1.44
Water supply	1.35
	76.11

Table XXI—Summary of Heating Load

No. of Heaters	Duty	Kw. Rating	Voltage
	WINTER LOAD		
9	Low-head pump house	37.500	550
1	Weigher's lab	11.000	550
1	Weigher's heater	2.500	550
1	Scale heater	1.000	110
1	Elevator penthouse	2.500	550
1	Lunch room	2.000	110
1	Chemical lab	4.125	550
1	Sad-iron heater	0.825	110
1	Sad-iron heater	1.650	110
1	Motor baking oven	2.500	550
3	Sub-station heaters	15.000	550
21		80.6	
	SUMMER LOAD		
1	Weigher's lab	11.000	550
1	Chemical lab	4.125	550
1	Sad-iron heater	0.825	110
1	Sad-iron heater	1.650	110
1	Motor baking oven	2.500	550
5		20.100	

Average yearly load—66.9 kw.

used and there is no slippage. In other words, it is a positive drive. It also causes less strain on the motor bearings. The disadvantages of chain drive are its cost and its speed limit, as it cannot be used where the speed is high. One thousand feet per min. is the limit for roller chain and 700 feet per min. for block chain. It is capable of transmitting greater power at slow speeds than the proportionate size of belt.

Where the driven machinery is exposed to the weather, as is the case with slasher saws and conveyors, chain drive has an advantage, not only because it is less affected by dampness, but due to the fact that the drive can be shortened; in fact, the driving and driven sprockets can be placed as close together as the size of the motor will allow.

Chain drive is also the proper type to use with conveyors since, as stated before, the drive is positive; with belts, the slippage and running off cause delays and loss of production.

The main advantage of the various kinds of belt drive, is the first cost. Where the belt is not subject to injury, through the action of chemicals or moisture, it may last indefinitely, providing the load it is driving is within its range. By far the greater number of drives in a pulp and paper mill are belt, owing mainly to the first cost. The main cost of the upkeep is probably labor, but since a mill has to have a certain number of millwrights, who are usually monthly men, the cost per unit is small.

In a paper mill, the greatest number of belts from one drive is the constant line. As all the units of the constant line are dependent on one another, it is the practice to put all the machines on one large motor, and thus group the drives. The number of machines in the group runs from twelve to fifteen, averaging in rating from 2 to 35 hp., on a 40-ton book machine. The list comprises plunger, centrifugal and suction pumps, air compressor, stock thickeners, agitators, screens and the shaker for the wire section or couch. Link leather belt on flanged pulleys is used for the super-calenders.

In a mill the size of this one the methods of obtaining the light and heat are of interest. The lights are supplied from two sets of 550-to-110-volt transformers. The sulphite and ground-wood mills are fed from three 15-kva. transformers connected in parallel across one phase; the paper mill is fed from two 30-kva. transformers in parallel across another phase. Two-wire, 110-volt lighting is used throughout, and while this method might be considered expensive, owing to dampness and acid fumes, it has been found economical, as no trouble has been experienced. The paper mill and ground-wood mill are equipped with R. L. M. dome reflectors throughout, except in the sulphite mill where the lighting is of such a nature that the use of reflectors is not permissible. The yard lighting consists of eighteen 500-watt units on wooden poles and three 1,000-watt floor lights which can be moved. The latter are used on the storage pile. Table XX shows the lighting load of the various departments. The yearly lighting load is 450,000 kw.-hr.

In certain parts of the mill, it was found that electric heating was more economical than any other method; for instance, in the low-head pumping station, which is one-third of a mile distant from the steam plant. It was also more dependable in heating the scales and in the various drying ovens. The load varies considerably. For the seven months dating from Oct. 25th to May 15th, the average load is 80.6 kw., while for the remaining five months, the average load is 20.1 kw. The average yearly load is 66.9 kw. or 89.6 horsepower. Table XXI shows the winter and summer heating loads.

Testing Armatures During Rewinding

(*Continued from page 377*)

a very low reading and also that a poor contact will give a high reading. When making tests on hand-wound armatures there are a number of causes that contribute to high and low readings. When testing an armature that has the commutator leads connected but not soldered, if the leads fit easily in the neck, consistent readings may not be obtained because poor contact may increase the resistance of the coil under test. Hence a series of high and low or irregular readings will be the result. Other things that may cause a variation in the readings are a large number of turns per coil, the use of small-sized wire in the coil, or one or two turns may have been left out of the coil. Sometimes a cord or tape band put on tightly over the leads just back of the commutator will cause the leads to make better contact in the neck and give more consistent readings in the bar-to-bar test. When a low reading is obtained in the bar-to-bar test and if there is any doubt about it being a short, use the growler.

Controlling Industrial Lubrication

(*Continued from page 372*)

is submitted for analysis together with a statement of the trouble.

It is very seldom that any trouble is found with the quality of the lubricant. Its purchase from a reliable company which knows that it is being carefully checked as to quality precludes any substitution of an inferior grade. This has only happened once in our experience. Needless to say, we make no further purchases from the concern in question. Most of the trouble with motor cars is due to not changing the oil in accordance with instructions, or to carelessness on the part of the driver in using his choke so frequently that he gets an abnormal amount of raw gasoline in the crankcase. In the case of machinery it is generally due to some changed condition in the operation of the machine which has not come to the notice of the *Engineering Department.*

The subject of laboratory control for lubrication problems is of too great length to be considered here. It is possible, however, for the average shop man to do something along this line without the assistance of a chemist. The specific gravity of the oil used may be determined by the ordinary hydrometer and the amount of dilution of the oil by foreign matter can be determined by comparing the specific gravity with that of a sample of fresh oil. Oil from a bearing which has been giving trouble can be warmed up to decrease its viscosity and filtered through several layers of cheese cloth. This will filter out any foreign matter in the oil, the nature of which can be generally determined by inspection as to whether it is metal from the bearing or shaft or whether it is foreign material drawn into the bearing during the operation of the machine. In complicated cases of bearing trouble it is, of course, necessary to have available the services of a chemist and laboratory. The rough tests outlined, however, will take care of a large number of cases of trouble which may occur.

Insulating Varnish Tests

(*Continued from page 385*)

stands up in actual service. No tests are of any particular value unless the results are backed by actual application to the manufactured product. Hence, it will be noted that in the interpretation of test results we have included all of the features interesting to the user of liquid insulators: namely, tests for physical and electrical characteristics, percentage of base, the cost per gallon and the endurance of the material under operating conditions in actual service.

So far the selection of varnishes has been based almost entirely upon the results of tests made either in the shop or in the laboratory upon small quantities of the materials in question. A selection so based is, however, unreliable when too much importance is placed upon these results because the results obtained by test even when conducted by the best scientific practice can seldom be duplicated. Take for example the test for dielectric strength; the best results obtained show a variation of 25 per cent when measured on the same sample. When specimens have been prepared on different days or by different operators these variations will be considerably greater. The same thing holds true in other tests. Take the one for drying time, for example. One laboratory has found that a certain varnish dries in 45 min.; another finds that the same material requires 55 hr., when apparently prepared in exactly the same way and baked under the same conditions.

Specifications for Insulating Varnishes

In many shops, particularly the large ones, it has been the practice to draw specifications for insulating varnishes, based upon elaborate laboratory tests to determine the characteristics of a varnish. The object of such specifications is to obtain a list of materials of different manufacture that will be suited to the work in hand and then allow the purchasing agent to select from this list that one which can be obtained for the lowest price. When these specifications contain a test for the percentage of base and allowance is made in the report to the purchasing department this practice is not so bad. It is, however, generally found that either almost any material will fit these specifications or else no material at all will fit them. The variations in the drying period described above illustrate this characteristic very clearly. In either case the specifications are of little or no value, so far as practical results are concerned.

The writer was shown a specification of this kind a short time ago. It described in great detail the tests to be made and the physical requirements of the varnish. When bids were asked the prices were found to range from $3.65 per gallon to $0.65 per gallon, and each bid contained a guarantee that the particular product quoted would fit the specification. Obviously when such a variation in price is permissible something is wrong.

Ideal Specifications Have Not Been Written

Steel has been purchased for many years by means of specification and the results appear to be entirely satisfactory. Perhaps, then, if varnish specifications were made out in a similar form equally satisfactory results would be obtained. We find, however, that in the specification for steel the chemical analysis is given. Perhaps if the raw materials entering into the composition of varnish were stated the problem would be solved. Unfortunately, however, the characteristics of these raw materials are often completely changed by the process of combining them so that the result has no semblance to the original substances. Any variation in the process changes the results; hence a description of the process should also be included in order to have the specifications complete and adequate.

Suppose this were done and the ideal specification written so as to include the substances used, the way in which they are to be combined and the physical tests which the finished product must pass; what assurance would the consumer have that his specification was being followed? In a properly constructed varnish the elements are so chemically combined that they defy an analysis even approaching accuracy. Hence, the customer would be unable to check up his source of supply unless he had an inspector present during manufacture and would soon find himself in the same position he is in now.

Since tests and specifications are unreliable, what then should be the true basis for varnish selection? Instead of attempting to approve as many different types of varnish and of as many different manufacturers as possible it would appear that the first step should be to select the supplier of these materials. This choice must necessarily be based upon confidence. Pick out those suppliers whose reputation and whose products have stood the test of time. Be sure that they understand the manufacture of insulating varnish. Be sure that they also understand the application of these materials to electrical work. In this way you will assure yourself of obtaining good materials and at the same time constructive ideas should trouble arise.

Then make sure that these different suppliers are furnishing you with the same grade of material and use your tests as a means of checking and of indicating to you the suitability of their products. Next try the materials offered in service and in production.

Selection of Proper Insulating Varnish Important

Insulating varnish is too important a factor to be overlooked either in the manufacture of a new machine or in the repair of an old one. Otherwise good results can be spoiled by the use of a poor or improper insulator. There is quite a similarity between the purchase and use of insulating varnishes and the purchase and use of clothing. One does not wish to wear a dress suit when greasing his automobile nor does he wish to wear overalls at the theater, but he does insist that the type of suit be adapted to his particular occupation and that it must be substantially made so as to give long wear. The difference in cost between overalls and a dress suit is considerable, and yet you cannot compare their value one with the other because they are used for different occupations, in which the requirements are different.

This holds true of insulating varnish. You must first determine what service your product is to perform and having determined upon the type of insulator, then you want to secure the best of this particular type. The reputable manufacturers of insulating varnish have no mysteries about their business and there is no reason why the electrical repair man should not have as thorough a knowledge of insulating varnishes as he has of any other product used in making electrical machines.

Achievements of Benj. G. Lamme

(*Continued from page 359*)

No. 633,856—Distributed winding for electrical machines, Feb. 6, 1899.
No. 633,857—Dynamo-electric generator, April 14, 1899.
No. 633,858—Field-magnet coil for electrical machines, June 14, 1899.
No. 633,972—Current collector for electrical machines, June 5, 1899.
No. 644,864—Electromotive-force regulation, Oct. 6, 1898.
No. 644,865—System of electrical distribution, June 14, 1899.
No. 646,092—Dynamo-electric machine, June 30, 1899.
No. 660,907—Single-phase a.c. generator, May 24, 1899.
No. 660,908—Variable-speed electric motor, June 5, 1899.
No. 660,909—Electric motor, Sept. 14, 1899.
No. 660,910—System of electrical distribution, April 14, 1900.
No. 660,911—Alternating-current induction motor, April 14, 1900.
No. 668,194—Rotary field-magnet for electrical machines, July 14, 1900.
No. 673,911—Polyphase, a.c. motor, Jan. 30, 1899.
No. 673,912—System of electrical distribution, July 14, 1900.
No. 673,913—System of electrical distribution, July 14, 1900.
No. 680,792—Alternating-current induction motor, May 24, 1899.
No. 680,793—Dynamo-electric generator, June 28, 1900.
No. 682,942—Rotary transformer, Jan. 28, 1897.
No. 682,943—Method of changing frequency of alternating currents, July 24, 1897.
No. 688,317—Winding for electrical machines, April 17, 1901.
No. 688,318—Winding for electrical machines, April 30, 1901.
No. 692,021—Regulation of rotary converter electromotive force, April 17, 1901.
No. 692,022—Winding for electrical machines, June 26, 1901.
No. 695,937—Alternating electric current generating and distributing system, July 31, 1896.
No. 695,938—Alternating-current motor, July 14, 1900.
No. 702,657—Speed regulating means for electric motors, April 30, 1901.
No. 702,658—Dynamo-electric generator, Sept. 24, 1901.
No. 710,158—System of electrical distribution, Oct. 14, 1901.
No. 710,363—Method of starting rotary converters. Original application filed Oct. 14, 1901. Divided and this application filed Feb. 1, 1902.
No. 731,466—Lighting apparatus for railway vehicles, Sept. 29, 1902.
No. 731,467—Electric lighting apparatus, Sept. 29, 1902.
No. 740,147—Electromotive-force regulator, Oct. 2, 1902.
No. 758,667—Single-phase, a.c. power system, Dec. 26, 1901.
No. 758,668—Single-phase, a.c. motor. Application filed Oct. 31, 1902, renewed Sept. 24, 1903.
No. 758,669—Brush holder for electrical machines, Sept. 16, 1903.
No. 759,183—Method of utilizing single-phase, a.c. energy. Original application filed Dec. 26, 1901. Divided and this application filed July 16, 1902.
No. 765,185—Controlling apparatus for electrically-propelled railway vehicles, Sept. 29, 1902.
No. 775,334—Alternating-current electric motor, Feb. 27, 1904.
No. 780,045—Single-phase, a.c. motor, May 3, 1904.
No. 780,046—Armature winding for electric motors, May 3, 1904.
No. 780,047—Electric motor, June 30, 1904.
No. 794,362—Electric motor, May 3, 1904.
No. 794,363—Electric motor and controlling means therefor, Jan. 3, 1905.
No. 807,943—Regulating means for system of electrical distribution, Feb. 1, 1905.
No. 811,231—Alternating-current motor, June 30, 1904.
No. 811,644—Single-phase, a.c. motor, Feb. 27, 1904.
No 814,380—System for variable-speed operation of a.c. motors, Oct. 8, 1904.
No. 819,770—System of electrical distribution, June 30, 1904.
No. 821,044—Induction motor, Feb. 27, 1904.
No 822,376—System of applying a.c. electrical energy, Sept. 22, 1904.
No. 834,582—Controlling device, Jan. 3, 1905.
No. 838,034—Electrical machine, Feb. 21, 1905.
No. 839,935—Phase-adjusting means for a.c. motors, Feb. 6, 1905.
No. 839,936—Phase-adjusting apparatus, Feb. 6, 1905.
No. 839,937—Method of regulating the speed of electric motors, Feb. 6, 1905.
No. 840,001—Method of regulating a.c. motors, Feb. 6, 1905.
No. 854,897—Armature for dynamo-electric machines, Sept. 20, 1906.
No. 856,477—Alternating-current motor, Feb. 27, 1904.
No. 885,163—Armature winding for high-speed, dynamo-electric machines, June 2, 1905.
No. 888,514—Armature winding for electrical machines, Aug. 17, 1904.
No. 888,912—Method of operating and system of control for electrical generators, Aug. 2, 1906.
No. 896,220—Electric locomotive, Jan. 5, 1907.
No. 900,289—System of control for electric motors, Dec. 4, 1905.
No. 900,555—Controlling system for electric motors, Original application filed Dec. 4, 1905. Divided and this application filed Feb. 24, 1908.
No. 905,889—Coil support for dynamo-electric machinery, June 28, 1905.
No. 911,018—Electrical apparatus, May 6, 1907.
No. 913,017—Dynamo-electric machine. Application filed Aug. 2, 1906. Renewed July 3, 1908.
No. 923,666—Protective device for commutator-type, a.c. motors, June 30, 1904.
No. 923,667—Winding for electrical machines, June 2, 1905.
No. 924,799—Electrical equalizing system. Sept. 3, 1907.
No. 925,355—Method of, and means for, operating dynamo-electric machines, Aug. 2, 1906.
No. 925,356—Electrical load-equalizing system. Original application filed Sept. 3, 1907. Divided and this application filed Nov. 6, 1908.
No. 925,357—Electrical equalizer system. Original application filed Sept. 3, 1907. Divided and this application filed Nov. 30, 1908.
No. 931,130—Commutator for dynamo-electric machines, Oct. 7, 1908.
No. 933,765—Winding for armatures of dynamo-electric machines, Nov. 3, 1906.
No. 940,698—Dynamo-electric machine, Sept. 13, 1905.
No. 947,389—Dynamo-electric machine, June 2, 1905.
No. 964,658—Method of operating electric motors. Application filed May 3, 1904. Renewed Oct. 20, 1908.
No. 964,659—Means for operating and controlling single-phase, a.c. motors. Application filed May 3, 1904. Renewed May 19, 1909.
No. 964,793—Method of operating and controlling single-phase, a.c. motors. Original application filed May 3, 1904. Divided and this application filed July 9, 1906.
No. 964,794—System of control for electric motors. Original application filed May 3, 1904. Divided and this application filed April 5, 1907.
No. 977,640—System of operation for dynamo-electric machines, March 15, 1906.
No. 977,641—System for the operation of dynamo-electric machines, March 15, 1906.
No. 978,038—System of regenerative control for electric motors. Original application filed March 15, 1906. Divided and this application filed Nov. 8, 1907. Renewed May 20, 1910.
No. 1,007,457—Coil support for dynamo-electric machinery, April 13, 1905.
No. 1,018,571—Dynamo-electric machine, April 10, 1908.
No. 1,031,009—Dynamo-electric machine, Sept. 6, 1910.
No. 1,066,507—System of control for electric motors, Sept. 26, 1910.
No. 1,070,492—Winding for dynamo-electric machines, Jan. 26, 1910.
No. 1,074,125—Method of operating induction motors, July 6, 1908.
No. 1,082,532—Dynamo-electric machine, Feb. 21, 1911.
No. 1,095,331—Field-magnet winding for dynamo-electric machines, Jan. 26, 1910.
No. 1,123,321—Method of operating polyphase induction motors, July 6, 1908.
No. 1,138,672—Dynamo-electric machine, Sept. 10, 1909.
No. 1,138,673—Switching device, Oct. 31, 1913.
No. 1,150,043—Dynamo-electric machine, Jan. 26, 1910.
No. 1,151,804—Electric motor, Jan. 26, 1910.
No. 1,158,511—Polyphase synchronous motor, Jan. 7, 1911.
No. 1,158,512—Two-speed induction motor winding, Jan. 24, 1914.
No. 1,186,804—Equalizing means for dynamo-electric machines, July 24, 1912.
No. 1,189,703—Alternating-current motor, Jan. 26, 1910.
No. 1,241,523—Control system, Feb. 25, 1914.
No. 1,243,307—System of distribution and control, March 23, 1914.
No. 1,243,430—System of distribution and control, Dec. 26, 1913.
No. 1,244,509—Dynamo-electric machine, Aug. 22, 1913.
No. 1,244,510—Universal motor, July 30, 1914.
No. 1,244,511—Universal motor, Aug. 7, 1914.
No. 1,246,617—System of distribution and control, March 23, 1914.
No. 1,275,945—Switching device, Aug. 2, 1913.
No. 1,295,906—Speed control for induction motors. Original filed Jan. 5, 1915. Divided and this application filed Oct. 21, 1916.
No. 1,300,742—System of control, Jan. 5, 1915.
No. 1,305,126—Switchboard apparatus, April 29, 1915.
No. 1,316,798—Dynamo-electric machine, May 2, 1917.
No. 1,318,775—Speed-controlling system for induction motors, Feb. 19, 1914.
No. 1,333,664—Speed control for induction motors, Oct. 21, 1916.
No. 1,336,566—Speed-control system for induction motors, May 2, 1918.
No. 1,387,496—Speed control for induction motors, Oct. 21, 1916.
No. 1,390,624—System of electrical ship propulsion. June 29, 1918.
No. 1,392,182—Means for preventing commutator flashing, June 17, 1918. Renewed July 9, 1921.
No. 1,416,038—Driving system for gyroscopic stabilizers, Feb. 19, 1917.

Changes in Distribution System

(*Continued from page 380*)

As shown in Fig. 2, the trough system of wiring was used, inasmuch as it is the most practical for this kind of an installation. All of the wiring is concealed and is thus fire proof and danger proof, but is readily accessible when occasion arises. The trough was made of No. 14 galvanized iron with sectional covers which are fastened on with machine screws.

In the underground work, fiber conduit was used throughout except in the case of short runs for service to buildings. Digging of the trenches was done by the inmates of the institution as well as could have been done by paid help. In laying the duct a 4-in. concrete base was first laid using a 4:3:1 mix. The ducts were, for the most part, laid four wide with 1 in. between ducts and 1 in. of concrete over the ducts. A 3-in. slab was placed on the top layer of ducts. Throughout the installation all of the equipment and manholes were so laid out that it is impossible for the inmates to interfere with them in any way. All manholes in which any transformers or other equipment is installed, are

7 ft. long, 5 ft. wide and 6 ft. high; all others are 4 ft. square by 5 ft. high. In Fig. 3 is shown a diagram giving the location of the buildings and high- and low-tension feeders.

All of the manholes have two 8-in. x 4-in. steel I-beams buried in the top slab, 1 in. below the manhole ring, and are reinforced with ¾-in. and ⅜-in. round steel. The walls are 8 in. thick with a 12-in. top and a 10-in. bottom. All of the manholes have sewer connections and are equipped with pressed-steel cable racks and hooks. At suitable locations 2,400-volt subway junction boxes of the disconnecting type are used for testing purposes. All joints are wiped with lead—no stuffing-type joints are used anywhere.

All underground transformers are protected with oil cutouts on the primary side, with a secondary distribution subway box on the secondary side. As a precaution, a test was taken on all of the oil before it was placed in the transformers, as it had been stored outside during the winter, but moisture was found in only one drum. All neutrals are grounded in the manholes as well as at the building entrance. Where three-phase power was needed as well as single phase, the transformers were connected open-delta.

Since this new installation has been completed, the maintenance on all electrical work has been cut somewhat over 50 per cent, and the power bill has been considerably lowered owing to better voltage regulation, making the use of smaller motors possible, and the clearing up of many badly grounded circuits.

Trade Literature
You Should Know About

Copies of literature which is described on this page can be obtained by writing to the manufacturer whose name and address are mentioned. It is always advisable to state the name and number of bulletin or catalog desired, as given in these columns.

Charles Bond Company, 617-619 Arch Street, Philadelphia, Pa.—Booklet S describes the Bond litestrong pressed steel shaft hanger and the junior pressed steel counter shaft hanger and counter shaft bearings, together with dimensions and prices.

The Nichols-Linchern Company, 7960 Loraine Avenue, Cleveland, Ohio—A series of light-weight universal signal lights which are made with a cast aluminum body and carry a 4-in. corning lens in either ruby, green, yellow or clear, are described. These are used for building exits, tower-house signals, train signals, steel mill yards or in any other place where it is necessary for danger, caution or clear signal to be placed. These lights are made in 1-way or 5-way type or may be used in a light-weight, large or small signal lantern. The aluminum gives light weight, resists rust, is not affected by dusty, acid or moist atmosphere and will not break under rough handling. These are made with bases for several different methods of attachment.

General Electric Company, Schenectady, N. Y.—Bulletin Y-1910 describes the new Emmett mercury vapor process in the generation of power.

The Republic Rubber Company, Youngstown, Ohio—An 8-page booklet describes the different grades of industrial fire hose. This includes hose for chemical extinguishers and chemical engines as well as double- and single-jacket, cotton, rubber-lined hose.

Lumen Bearing Company, Buffalo, New York—A 16-page booklet discusses the two following subjects: "Bushing—A Proper Driving Fit," and "Oil Grooves—Fitting Up Bearings."

Harold E. Trent, 1524 Chestnut Street, Philadelphia, Pa.—Leaflet T-A 2 describes and prices the Trent automatic control system for continuous service which not only indicates the temperature on a dial but controls the temperature by setting a lever to scale. Types 800 and 801 have a maximum range of 1,000 and 1,200 deg. F., respectively. Other types are made for a temperature from 100 up to 400 deg. This may be used for controlling electrically-heated devices, gas, steam, oil or air-heated appliances, for operating air or fuel valves independently or in conjunction, or for controlling the ratio of air and fuel valves and other uses.

Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.—Folder 4532-A entitled: "Westinghouse Fabrics and Papers," describes and gives the principal applications, together with tables of thickness with approximate weights and size of the various forms of treated and untreated fabric, papers, sleeving, tapes, cord and thread manufactured by this company for insulating purposes.

The E. F. Hauserman Company, 1729 East Twenty-second Street, Cleveland, Ohio—Bulletins describe the Hauserman system of steel partitions, factory shelving and skylights. Sketches show the arrangement whereby each of these is erected.

The Alexander Milburn Company, 1416-1428 West Baltimore Street, Baltimore, Md.—A booklet entitled "Milburn Welding and Cutting Apparatus" describes the various types of acetylene generators and welding and cutting torches. Special oil-burning, preheating equipment is included.

The Cutter Company, Nineteenth and Hamilton Streets, Philadelphia, Pa.—The "Handbook on the U-Re-Lite" Series O, is of pocket size and devotes 96 pages to illustrations and descriptions of the various types of Cutter U-Re-Lite equipment. The size and description of each of the various sizes and some of the topics discussed are: The automatic features, overload, dalite (direct-acting time-limit) feature, time-overload curves of dalite, no-voltage feature, shunt trip feature, bell ringing feature and a discussion of the selection of the U-Re-Lite for specific service conditions.

Eldredge Electric Manufacturing Company, Springfield, Mass.—A group of small folders describes the Eldredge miniature panel ammeters and voltmeters and pocket-type ammeters, voltmeters and volt-ammeters.

L. J. Wing Manufacturing Company, 352-362 West Thirteenth Street, New York City—A folder describes the Wing "Featherweight" unit heater for heating industrial plants. These units are installed near the ceiling or roof to take the warm air from the higher levels, heat it and return it again to the working levels by mechanical means and so speed up the circulation and heating of a building.

Rockbestos Products Corporation, New Haven, Conn.—A thirty-two-page catalog, illustrated in three colors, has been prepared to serve as a reference for those interested in the use of asbestos-covered wire and cables and supplies sufficient information in regard to Rockbestos products to enable a user to make the proper selection of the wire best suited to his purpose.

Edwards and Company, Inc., One Hundred Fortieth and Exterior Streets, New York City—Catalog 9 covers the various selective signaling devices such as bells and buzzers, annunciators, push buttons, battery switches, door openers, various types of relays, burglar alarms, watchman's time detectors, fire alarms and code stations.

The Standard Electric Tool Company, Cincinnati, Ohio—A folder describes the Standard floor, tool post and bench grinders, the line of hand and screw feed electric drills and the combination portable bench stand for use with electric drills.

Diamond Saw and Stamping Works, Buffalo, N. Y.—Bulletin 18 covers the Sterling hacksaw blades for hand frames and power machines.

U. S. Light and Heat Corporation, Niagara Falls, N. Y.—Bulletin No. 789-A gives what the manufacturers believe are a dozen reasons why U. S. L. arc welders are endorsed by users.

Ajax Flexible Coupling Company, Westfield, N. Y.—An 18-page booklet describes the Ajax flexible coupling, its construction, the method of operation and gives the dimensions and prices for the various sizes as well as illustrations showing some of the applications and a partial list of users.

Crouse-Hinds Company, Syracuse, N. Y.—A folder entitled "Condulets for Concealing in Concrete" describes and dimensions condulet and fixtures of the SK series for use in permanent concrete construction. Details of a number of applications are included.